ILLINOIS NATURAL HISTORY SURVEY

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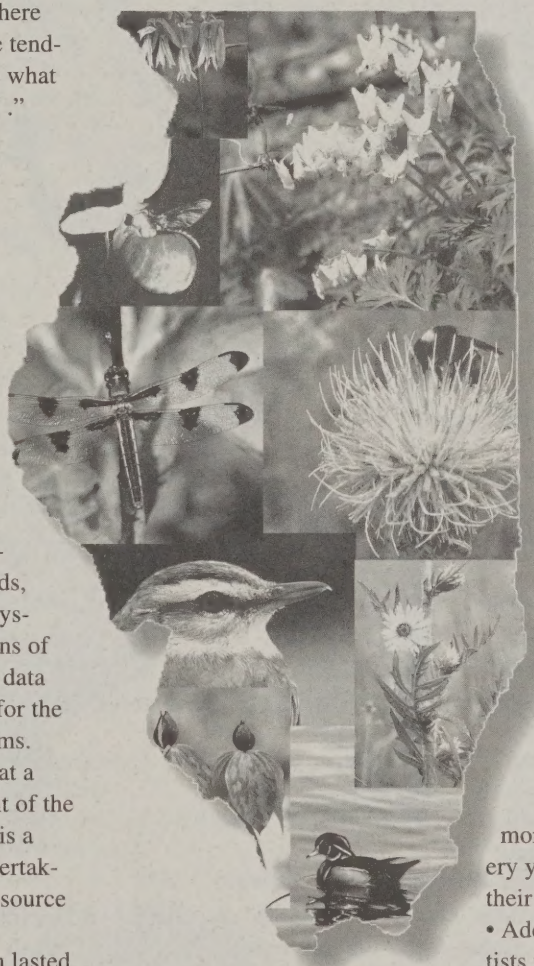
INSIDE

Critical Trends Assessment Program Update

"If we could first know where we are and whither we are tending, we could better judge what we do and how to do it. . . ." This quote from Abraham Lincoln, however removed from our present context, sums up what the Critical Trends Assessment Program (CTAP) is all about. CTAP, managed by the Division of Energy and Environmental Assessment, of the Illinois Department of Natural Resources (IDNR), is designed to evaluate the current condition, future trends, and extent of Illinois ecosystems and to provide citizens of the state with some of the data necessary to forge a plan for the future of Illinois ecosystems. CTAP is the first attempt at a comprehensive assessment of the Illinois environment, and is a unique and ambitious undertaking among state natural resource organizations.



Phase I of this program lasted from 1991 to 1994 and culminated in *The Changing Illinois Environment: Critical Trends*, a seven-volume report summarizing existing information on the condition of Illinois ecosystems. While it concluded that the discharge of regulated pollutants had drastically declined since 1970, it pointed to continuing decline of ecosystem condition due to habitat fragmentation and introduced species. The most important finding, and one that prompted a phase II of CTAP, was that available data were insufficient to accurately assess ecosystem condition on a statewide basis. This lack of standardized information initiated four distinct components:

- Land-cover mapping of the entire state to document the extent of several target ecosystems and land-use patterns and to develop a protocol for choosing random sample locations within the target ecosystems.
- Establishment of a team of professional scientists at the Illinois Natural History Survey (INHS) and a larger network of dedicated, well-trained "citizen scientists" (with coordinators and trainers, part of the Illinois EcoWatch Network) to sample the state's forests, wetlands, grasslands, and streams using standard, scientifically valid protocols. The professional scientists would carry out detailed sampling at a relatively few sites each year, while the citizen scientists would sample many more sites, repeating them every year but with less detail than their professional counterparts.
- Additional professional scientists from the Illinois State Water Survey, the Illinois State Geological Survey, and INHS accumulate existing data in the form of regional assessments designed to inform citizen-led and IDNR-facilitated ecosystem partnerships across the state on how to protect, enhance, and restore their natural setting while dealing with ever-present growth and development issues.

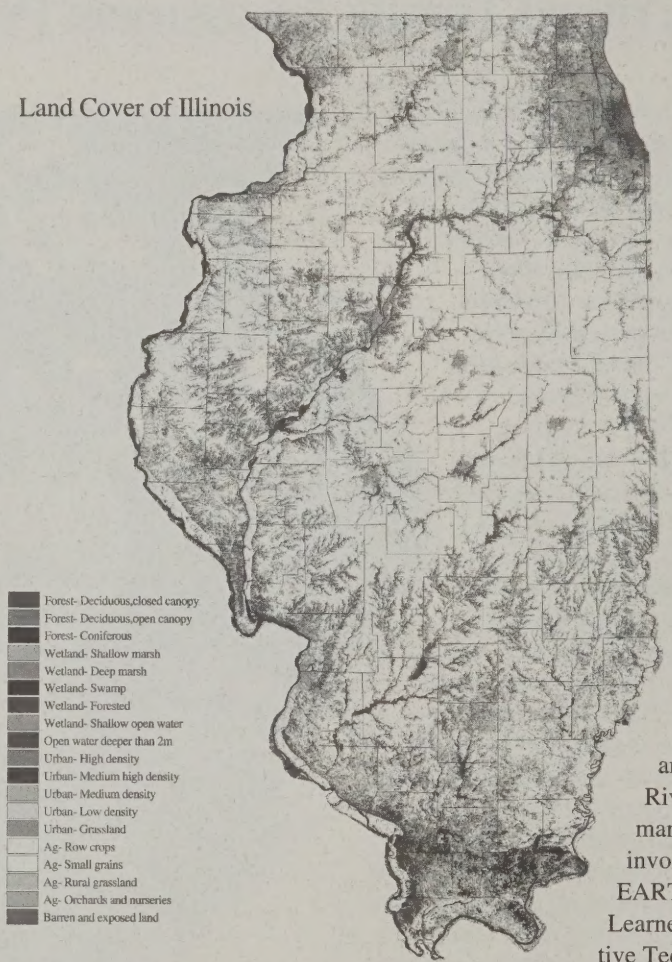
Continued on back page

CTAP, A FAR-REACHING PROGRAM

Land-cover Mapping: In 1996 *Illinois Land Cover: An Atlas* was published using data from satellite imagery (taken during 1991–1995) and digitized maps of county and township boundaries, roadways, and stream corridors. This includes a geographic information system (GIS) database, also available on compact disc, that provides a level of detail appropriate for regional analysis. These same data were used to provide a means of randomly choosing locations across the state, the basic unit of sample being the township, of which there are 1,700 available. Randomization also occurred within townships. So, one can see that without land-cover mapping, the program would be severely handicapped. This disc is available to ecosystem partnerships across the state to provide GIS capabilities for planning purposes.

The mapping of presettlement vegetation is another CTAP-funded project that will enable the State of Illinois to map, as accurately as possible, the original extent of Illinois ecosystems. Archived government land surveys that originally laid out counties, townships, sections, and property lines are a rich store of information on vegetative cover due to notes kept by surveyors. Interpreting these historic documents gives a reasonably accurate picture of the extent of ecosystems across the state. Without this type of information, the state must rely on other, possibly less accurate, portrayals of the original vegetative cover in an area. Other projects include updating of land cover with new satellite imagery in rapidly developing areas (i.e., suburban areas) to measure changing land use.

Regional Assessments: The state scientific surveys and the Illinois State Museum have been involved since 1996 in summarizing existing environmental data for use by citizen-led ecosystem partnerships. Partnerships are coalitions of local private landowners, business people, natural scientists, recreation enthusiasts, and local policy makers that have a common interest in the natural resources of their area. They are supported both financially and with information (assessments, land-cover data, advice) by Conservation 2000, a multiyear initiative to preserve and restore Illinois' natural resources.



Regional assessments are comprised of four volumes: *Geological*, *Water Resources*, *Living Resources*, and *Socio-Economic Profile/ Environmental Quality/ Archeological Resources/ Early Accounts*. A color brochure, *An Inventory of the Region's Resources*, accompanies these four. To date, 22 regional assessments have been completed. Six more will be finished by late 2000, while four additional regions will be covered in 2001. Set your browser to http://dnr.state.il.us/orep/c2000/index.htm to learn if an assessment exists for your region. To order copies of regional assessments call the IDNR Clearinghouse at (217) 782-7498 or TDD (217) 782-9175.

Education: Since large numbers of citizen scientists help monitor the condition of Illinois ecosystems, an educational component is necessary to train volunteers. A small number of trainers, stationed at six locations across the state, support this army of volunteers. These INHS employees hold training workshops, accompany new volunteers to the field, give talks to local organizations, and provide quality assurance for volunteer data. Without these dedicated employees, the volunteer monitoring effort would not be successful.

Dr. Michael R. Jeffords and Carolyn Nixon, both INHS employees, provide support for the development of programs and teaching aides for the Illinois EcoWatch Network. They have been instrumental in the development of WetlandWatch and in revamping the RiverWatch monitoring manual. Dr. Jeffords is also involved in the PLAN-IT EARTH program—Pairing Learners and Nature with Innovative Technology for the Environmental Assessment of Resources Trends and Habitats. High school students participate in a hands-on environmental sciences program designed to meet several goals set by the State Board of Education. These high school students use EcoWatch monitoring procedures, submit the data to a central database, and prepare reports on their activities for class. In this way, EcoWatch gains data and instills a sense of citizenship. An added bonus is that some of these students become dedicated and well-trained volunteers after they leave high school.

CTAP MONITORING FRAMEWORK

The success of this framework depends upon a partnership between INHS professional and EcoWatch citizen scientists. Protocols for these sister organizations are complementary. Professionals conduct detailed surveys at a relatively few randomly selected sites in each ecosystem (Table 1). This permits inference of the condition of the ecosystems across the whole state. Volunteers conduct a subset of the professionals' procedures, but with less taxonomic resolution at random and nonrandom locations. These random locations help to put the results of the nonrandom sites into a statewide and regional context.

Random Locations: Protocols determined structurally and functionally representative locations for forests, wetlands, grasslands, and streams. An on-site assessment of the suitability of each location ensured that sites met basic criteria. For example, forests grazed so heavily as to be devoid of shrub and ground layers were unacceptable, and the search continued for an acceptable location. Most professional monitoring took place on privately owned land, which necessitated contact with landowners and negotiation for access to their property. It has been a great way to meet the citizens of the state and tell them of the goals of the program. Figure 1 represents all the townships planned for monitoring by professionals, while RiverWatch and ForestWatch volunteer sites visited through 1999 are in Figure 2.

Choice of What to Measure: While it was difficult to know exactly what information might be important to gather from these four ecosystems, CTAP professionals knew they could not measure everything. Careful deliberation resulted in the choice of several plant and animal assemblages, chemical and physical parameters, and habitat features that could yield ecological indicators capable of assessing site conditions (Table 2). The choice of assemblages reflected the strengths of professionals at the INHS and the guidance of available scientific literature. More

Table 1. Number of sites, sampling frequency, and time frame for professional and volunteer monitoring.

	# Sites Year/ Total		Frequency (years) and Time Frame	
Ecosystem	Professional	Volunteer	Professional	Volunteer
Streams	30/yr 150 total	100 random/yr +volunteer-selected	Every 5 yr April–May	Yearly May–June
Forests	30/yr 150 total	50 random/yr 100 total random +volunteer-selected	Every 5 yr May–June	Every 2 yr April–May & Aug.–Sept.
Grasslands	30/yr 150 total	25 random/yr 50 total random +volunteer-selected	Every 5 yr August	Every 2 yr Aug.–Sept. 15
Wetlands	30/yr 150 total	25 random/yr 50 total random +volunteer-selected	Every 5 yr July	Every 2 yr July–Sept. 15

Table 2. Assemblages of organisms used and ecological indicators generated from them in CTAP's ecosystem monitoring framework.

Streams

Fishes

Species richness
Species dominance
Percentage non-native species
Index of Biotic Integrity (IBI)

Benthic Macroinvertebrates

Total taxa richness*
EPT species richness
Taxa dominance*
Macroinvertebrate Biotic Index (MBI)*
Hilsenhoff Biotic Index (HBI)

Physical/Chemical Parameters

Habitat Quality Index
Stream width, depth, discharge*
Temperature
Dissolved Oxygen
pH
Conductivity

Forests, Grasslands, Wetlands

Plants

Species richness and diversity*
Species dominance*
Coverage of non-native, sensitive, & Threatened & endangered*
Floristic Quality Index

Terrestrial Insects

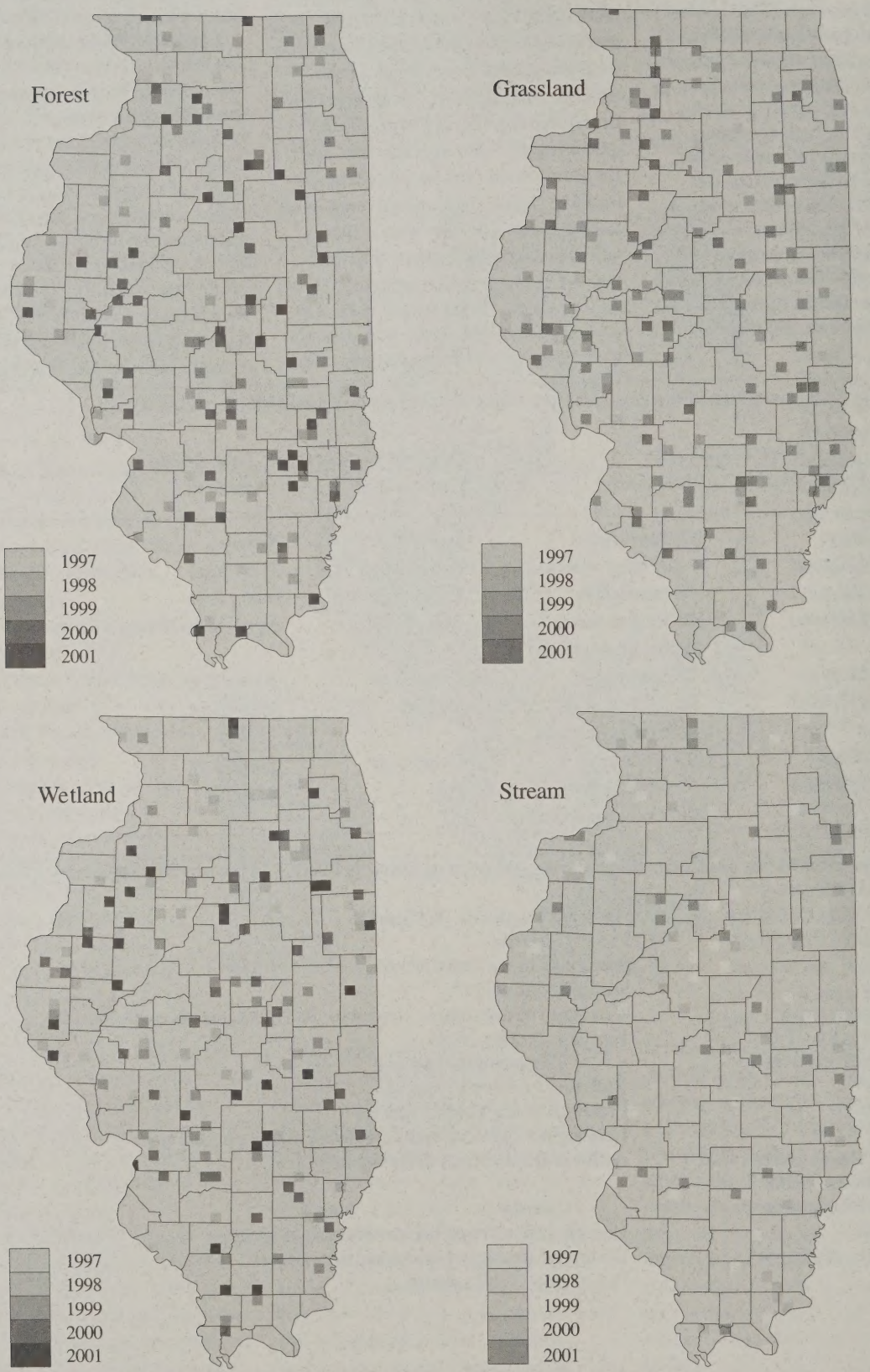
Richness of morpho-species
Presence of leafhopper species
Leafhopper Index of rarity, endemicity, & simplicity
Arthropod functional diversity index

Birds

Diversity/ density of habitat dependent species
Diversity/ density of area sensitive species
Presence of T&E species

*Used by CTAP researchers and citizen scientists.

Figure 1


Forest
1997
1998
1999
2000
2001
Grassland
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1998
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2000
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Wetland
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Stream
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than one assemblage per habitat is necessary because environmental challenges are varied and not all assemblages respond the same to them. CTAP used several ecological indicators, abstractions of information derived from the contents of samples, to assess condition. A multiple indicator approach generally provides a more accurate assessment of conditions than does a single measure.

CTAP professionals have been sampling since 1997, having collected baseline data in four years of a five-year cycle. In 2002, professionals resample these locations. This report contains preliminary analyses of up to three years of professional data, five years of RiverWatch, and two years of ForestWatch.

RESULTS

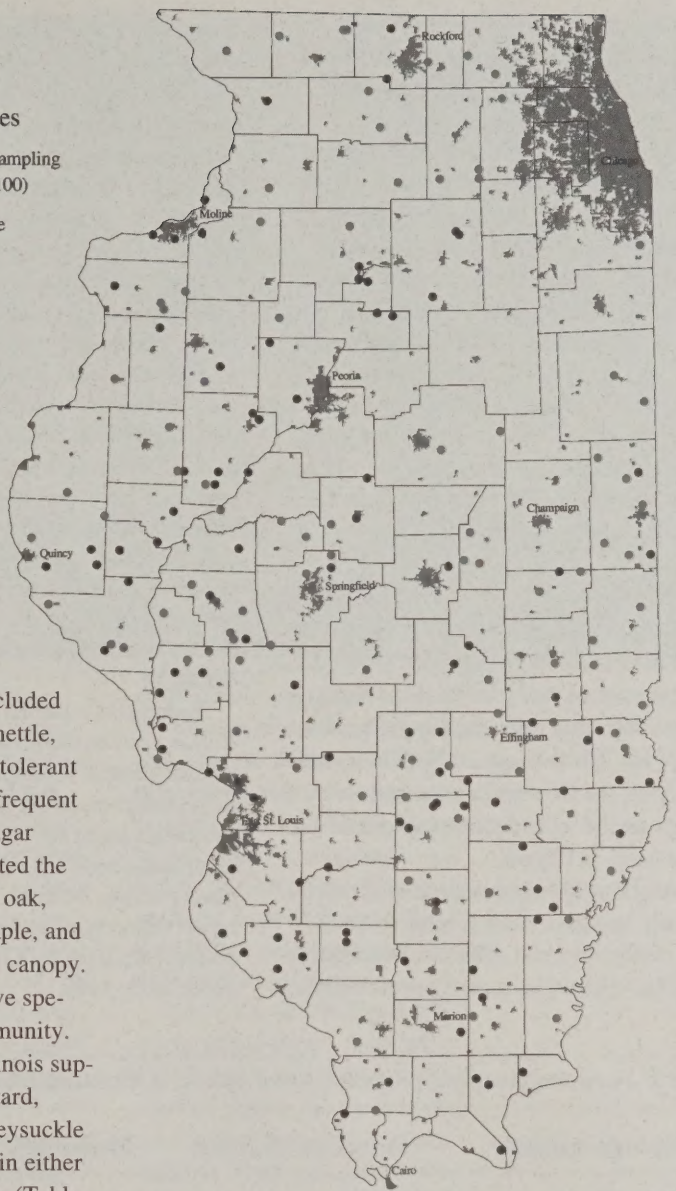
Forest Ecosystem: Roughly 38% of Illinois was forested in the mid 19th century; today, only 14% of the state remains forested. CTAP professionals recorded an average of 61 plant species (range 19–108) at 73 forest sites. These forest sites ran the gamut of condition from poor to excellent. Interestingly, CTAP forest locations supported no threatened or endangered species. Sensitive species, those found in relatively undisturbed habitats, averaged 1.1 species and occurred in only 21 of the 73 forest sites. Non-natives averaged a low 3.0 species, occurring at 58 of the 73 sites.

Figure 2

Ecowatch Sites

Potential Sections for Sampling
(statewide rank 1- 100)

● = EcoWatch Site



Most dominant species in the ground layer were native but often included Virginia creeper, wood nettle, and black snakeroot, all tolerant of disturbances such as frequent logging and grazing. Sugar maple saplings dominanted the shrub layer, while white oak, American elm, sugar maple, and black oak dominated the canopy.

Regionally, non-native species dominated the community. The northern third of Illinois supported either garlic mustard, buckthorn, or shrub honeysuckle as the dominant species in either the ground or shrub layer (Table 3). Alternatively, multiflora rose and Japanese honeysuckle domi-

Table 3 . Non-native species in professionally monitored forest sites, by region. Number of sites monitored is in parentheses.

Region →	**Northern (18)**		**Central (35)**		**Southern (20)**		**Statewide (73)**
Species	# sites found	# sites dominant	# sites found	# sites dominant	# sites found	# sites dominant	# sites found
Multiflora rose	9	0	19	4	6	0	34
Shrub honeysuckle	6	1	7	0	0	0	13
Japanese honeysuckle	0	0	4	3	6	1	10
Garlic mustard	5	2	2	0	0	0	7
Buckthorn	4	4	2	0	0	0	6

nated in 7 of 35 sites in central Illinois. Southern Illinois supported non-natives in the forest, but they only rarely reached dominant status.

Seven area-sensitive, forest-dependent bird species occurred on average at CTAP professional sites. These species generally decline in abundance as forest habitat is fragmented (becomes smaller and more isolated). Ten of the 24 species listed in Table 4 are highly sensitive to habitat fragmentation. An average of 0.67 of these species occurred at CTAP sites. Although historical data are lacking on the diversity and abundance of these 10 species, an average of less than 1 species per site clearly reflects the degraded condition of forest patches in Illinois.

Fragmentation of forest habitat leads to greater edge availability. These edges often harbor the Brown-headed Cowbird, a nest parasite of many birds. Cowbirds had greater detection rates than any other bird except the White-breasted Nuthatch, which highlights the Cowbird's potential for impact on the reproductive success of forest birds in Illinois.

ForestWatch volunteers reported that disturbance-sensitive plant species (blue cohosh, white flowered trilliums, Dutchman's breeches, squirrel corn, doll's eyes, bellwort, hepaticas, Virginia spiderwort, and maidenhair fern) occurred at less than 20% of the 133 sites monitored. The most common of these were squirrel corn and Dutchman's breeches, present at 19% of the sites. The rarest disturbance-sensitive species, the hepaticas, occurred at only 6% of the sites.

Volunteers found that non-native ground-cover species outdistanced disturbance-sensitive natives by a 2.5X margin in total area. Garlic mustard, the most common non-native ground-cover species, occurred at 31% of the sites investigated. In the shrub layer, non-natives averaged more than twice as many stems per hectare than natives. Anthracnose, a fungal pathogen of flowering dogwood, occurred at 5 of 16 sites where dogwoods were present. Volunteers reported no evidence of the gypsy moth, a tree leaf defoliator.

Volunteers reported evidence of a shift in community structure of forests whereby maple saplings tended to establish themselves better than did the oaks and hickories of the canopy. Eleven of 40 upland forest sites demonstrated this phenomenon. Volume 3 of the CTAP I report stated that between 1962 and 1985, maples increased by 41-fold, while oaks declined by 14%.

Grassland Ecosystem: In the 19th century, native prairies once covered approximately 61% of Illinois, generally dominating the landscape in central and northeastern Illinois. Roughly 2,300 acres of high-quality prairie remain, about 0.01% of the pre-European settlement acreage. Most of the grasslands currently listed in the land-cover database (6,932,409 acres, 19.2% of the state) are occasionally plowed, heavily grazed, or frequently mowed and do not resemble native prairies.

Professionals recorded an average of 20 plant species per site (range 6–33 species) at 71 sites. By comparison, high-quality prairie remnants may contain 100 to 140 species in only a few acres. Dominant native species included common goldenrod, red top, big bluestem, trumpet creeper, switch grass, and bead grass. CTAP sites supported few sensitive grassland species and samples revealed no threatened or endangered species. On the contrary, non-native species contributed about 38% of the average total species richness. Even though non-native richness was not extraordinarily high, this assemblage provided the domi-

Table 4. Area-sensitive, forest-dependent bird species in Illinois and their detection rates in CTAP professionally monitored sites.

Highly area sensitive	Detection (% Sites)	Moderately area sensitive	Detection (% Sites)
Ovenbird	17.5%	White-breasted Nuthatch	85.0%
Pileated Woodpecker	13.7%	Tufted Titmouse	77.5%
Louisiana Waterthrush (As)	12.5%	Yellow-billed Cuckoo	67.5%
Worm-eating Warbler (S)	3.7%	Red-eyed Vireo	65.0%
American Redstart	3.7%	Scarlet Tanager	47.5%
Brown Creeper	1.2%	Blue-gray Gnatcatcher	46.2%
Cerulean Warbler	1.2%	Wood Thrush	43.7%
Veery (N)	0	Acadian Flycatcher (As)	41.2%
Black and White Warbler	0	Kentucky Warbler (As)	30.0%
Hooded Warbler (As)	0	Hairy Woodpecker	25.0%
		Yellow-throated Vireo	21.2%
		Northern Parula	18.7%
Nest parasite		Summer Tanager (As)	11.2%
Brown-headed Cowbird	82.6%	Yellow-throated Warbler (As)	5.0%

* Species on the edge of their range or those not adequately censused by point counts (e.g., raptors and night birds) are not included. (S) = Predominantly in southern Illinois, (As) = statewide but predominantly in the south, (N) = only northern Illinois.

nant species at 84.5% of all sites. Cool-season grasses contributed nearly all of these non-natives, where they dominated most heavily in northern and central Illinois (Table 5). Most professional sites included pastureland, old fields, hayfields, and transportation rights-of-way, often planted in non-native grasses. Trees and shrubs were not dominant in any of the CTAP grasslands, since acceptable sites were limited to less than 50% tree and shrub cover. Non-native trees and shrubs included Osage orange, white mulberry, Siberian elm, and multiflora rose.

A highly fragmented landscape typical of much of Illinois.

Professionals censused birds at 75 grassland sites during 1997–1999. The 12 species listed in Table 6 are area-sensitive, grassland-dependent species and their presence serves as an indication of grassland condition. Professionals detected an average of only 2.0 area-sensitive species per site. While a few of the 12 species in Table 6 do not occur statewide, this value is very low when compared to historical data gathered by other INHS scientists. CTAP professionals detected Eastern Meadowlarks, a species of medium sensitivity, more frequently than any other species. It appears that this species does well in the small, degraded patches of remaining grassland habitat. From these data, it might be inappropriate to maintain its status of medium sensitivity. Professionals also reported that the Brown-headed Cowbird had a high rate of detection. Cowbirds reproduce rapidly, having the capacity to introduce their eggs into the nests of many birds in a single growing season. They represent a significant threat to sensitive-species reproduction.

A potential bellwether species in grasslands is the Bobolink, whose numbers declined by over 90% in Illinois since 1966. Cropping, overgrazing, excessive mowing, and the small size of most parcels negatively impact the reproductive success of this and other bird species. CTAP established minimum criteria for acceptance of grasslands related to these factors, resulting in rejection of many sites. Hence, the peril that Bobolinks and other species face may well be greater than implied by our data.

Currently, EcoWatch is piloting its PrairieWatch program. Their protocols complement those of professionals. Within a short time, depending on availability of resources, volunteers will be monitoring this troubled Illinois ecosystem.

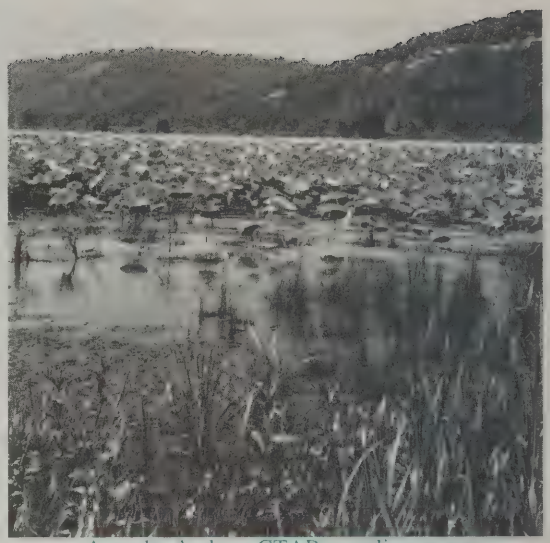
Table 5. Non-native species in professionally monitored grassland sites, by region. Number of sites monitored is in parentheses.

Region →	**Northern (14)**		**Central (41)**		**Southern (16)**		**Statewide (71)**
Species	# sites found	# sites dominant	# sites found	# sites dominant	# sites found	# sites dominant	# sites found
Hungarian brome	9	3	18	5	1	1	28
Meadow fescue	8	1	25	14	10	9	43
Tall fescue	0	0	0	0	3	3	3
Kentucky bluegrass	6	5	22	6	11	0	39
Canada bluegrass	5	1	7	4	3	0	15
Orchard grass	4	1	11	4	4	0	19

Wetland Monitoring: Natural wetlands in Illinois have declined from pre-European settlement estimates of 23% of the land area to 2.6%. Only 6,000 acres of high-quality wetland remain in Illinois, a little over half of all remaining wetlands. Wetland loss in the state has been the result of draining, filling, dredging, and urban development. Our remaining wetlands have degraded further due to fragmentation, siltation, altered hydrological conditions, and by the invasion of introduced species.

Professionals sampled 78 emergent wetlands between 1997 and 1999, and recorded 15 species (range 1–19) on average. Sensitive species richness was less than 0.2, with no threatened or endangered species. Sensitive species included snowy campion, rough bedstraw, bristly smartweed, northern bugleweed, and comb pondweed.

Non-natives averaged only two species per site; however, they often dominanted to the point of forming near monoculture when present. Table 7 demonstrates that of these non-natives, reed canary grass was the most dominant, especially so in northern and central Illinois. The common reed (*Phragmites* sp.), though considered native, has become invasive in disturbed wetlands of southern Illinois, usually forming an impenetrable monoculture when present. Common species detected in the shrub and tree layer included mostly native black willow, buttonbush, sandbar willow, green ash, silver maple, eastern cottonwood, peach-leaved willow, and American elm.



A wetland where CTAP sampling occurs.

Professional ornithologists censused 80 sites from 1997 to 1999. Many of these offered little suitable habitat for wetland-dependent birds, and many times contained species more representative of grassland ecosystems. While many of the birds that use wetlands are able to live in other habitats (e.g., Red-winged Blackbird, Song Sparrow, Common Yellowthroat), the 31 species listed

Table 6. Twelve area-sensitive, grassland-dependent bird species know to occur in Illinois grasslands, their relative sensitivity to area size, and detection rate (as % of sites visited). The Brown-headed Cowbird, a nest parasite, provided for comparison.

Bird Species	Sensitivity	Detection Rate	Bird Species	Sensitivity	Detection Rate
Henslow's Sparrow*	High	8.0	Eastern Meadowlark	Medium	69.3
Savannah Sparrow	High	8.0	Dickcissel	Low	48.0
Bobolink	High	6.7	Grasshopper Sparrow	Medium	22.7
Upland Sandpiper*	High	1.3	Sedge Wren	Medium	9.3
Northern Harrier*	High	1.3	Vesper Sparrow	Low	5.3
Short-eared Owl*	High	Not detected	Western Meadowlark	Medium	1.3
Brown-headed Cowbird	Nest parasite	64.0			

*State endangered species.

Table 7. Non-native species in professionally monitored wetland sites, by region. Number of sites monitored is in parentheses.

Region →	Northern (22)		Central (37)		Southern (19)		Statewide (78)
Species	# sites found	# sites dominant	# sites found	# sites dominant	# sites found	# sites dominant	# sites found
reed canary grass	13	6	20	16	5	2	38
meadow fescue	1	0	6	4	2	0	9
narrow-leaved cattail	2	1	0	0	5	0	7
barnyard grass	2	0	7	1	6	0	15
common reed*	1	0	0	0	5	5	6

* Species locally native in Illinois, but becoming invasive out of its original range in southern Illinois.

in Table 8 are truly wetland-dependent. Their presence serves as an indicator of wetland conditions. At least 18 of these species utilize wetlands in southern Illinois, while at least 27 species occur in the north.

Statewide, professionals detected only 19 wetland-dependent species known to occur in Illinois, reporting only 1.3 of these species per site. A disheartening finding was that more than 55% of the wetlands supported no wetland-dependent species. Twelve of 35 threatened or endangered bird species in Illinois depend upon wetlands to forage and rear young. Professionals detected only three of these species at only three (3.8%) of the sites. This rarity further reveals the degraded condition of the average Illinois wetland.

Table 8. Thirty-one wetland-dependent bird species known to occur in Illinois grasslands, their detection rates (% sites at which they were encountered), and statewide distribution.

Bird Species*	Detection Rate	Distribution	Bird Species*	Detection Rate	Distribution
Pied-billed Grebe[T]	2.5%	Statewide	Blue-Winged Teal	3.75%	Statewide
Double-crested Cormorant	1.25%	Statewide	Hooded Merganser	1.25%	Statewide
American Bittern[E]	not detected	N IL	King Rail[E]	not detected	N IL
Least Bittern[E]	2.5%	Statewide	Virginia Rail	1.25%	N IL
Great Blue Heron	25%	Statewide	Sora	1.25%	N IL
Great Egret	10%	Statewide	Common Moorhen[T]	1.25%	N IL
Snowy Egret[E]	not detected	S IL	American Coot	1.25%	N IL
Little Blue Heron[E]	not detected	S IL	Sandhill Crane[T]	not detected	N IL
Cattle Egret	not detected	S IL	Spotted Sandpiper	2.5%	Statewide
Green Heron	10%	Statewide	Common Snipe	not detected	N IL
Bl-crowned Night-heron[E]	not detected	Statewide	Black Tern[E]	not detected	N IL
Yl-crowned Night-heron[E]	not detected	S IL	Willow Flycatcher	15%	Statewide
Mute Swan	not detected	N IL	Marsh Wren	3.75%	N IL
Canada Goose	6.25%	Statewide	Swamp Sparrow	7.5%	N IL
Wood Duck	16.25%	Statewide	Yl-headed Blackbird[E]	not detected	N IL
Mallard	15%	Statewide			

*Three other wetland-dependent species (Forster's Tern, Black Rail, and Wilson's Phalarope) are on the state's threatened and endangered species list but were excluded from this analysis because Illinois is at the edge of their range and their occurrence in the state is extremely rare and/or sporadic. [E]= state endangered, [T]= state threatened.

CTAP Streams: Most stream courses at the turn of the 20th century were sinuous, associated with rich marshes that ameliorated flooding, had a treed riparian zone, and supported a diverse community of plants and animals. Streams of today face myriad challenges including nonpoint-source pollution (diffuse sources running off the landscape), channelization, erosion, sedimentation, and hydrologic modification. These disturbances and the point-sources of past and present have had severe impacts on the condition of our waterways. Irretrievable losses include the local extirpation or complete extinction of 11 fishes, 17 mussels, and several sensitive aquatic insects species.

CTAP professionals have sampled up to 120 stream sites during 1997–2000. Their primary indicators support the contention that streams in Illinois run the gamut from high-quality systems, worthy of Outstanding Resources Waters designation, to exceedingly poor conditions. The stream habitat quality index measures the condition of 12 parameters. A composite score, ranging from 0 to 180 (with 180 being of highest quality), was calculated for each of 87 sites monitored from 1997 to 1999. It provided a measure of the potential for in-stream and streamside habitat to provide food and shelter for aquatic organisms. This was the least forgiving of all stream indicators used by professional aquatic biologists. Statewide it averaged 88.6 points (range 25–146), a poor to fair rating. Figure 3a depicts an average Illinois stream, while Figure 3b depicts some of the best quality available.

Ephemeroptera, Plecoptera, and Trichoptera (EPT) species richness, an assemblage of insects that runs the gamut of sensitivity to pollution (but also contains some of the most sensitive aquatic species), averaged 7.1 taxa statewide (range 0–17). The Hilsenhoff biotic index (HBI) is an index of organic pollution in streams. This index runs from 0 to 10; a stream with HBI of 10 is of poor condition. It averaged 5.2 units (range 3.1 to 7.0) statewide. A midrange average such as this indicated that most streams sampled (and by virtue of these being randomly chosen, most streams statewide) were dominated by moderately pollution-tolerant EPT species indicating current or past degradation to a moderate degree. Even those sites with high EPT species richness, at least in

Figures 3 a & b. Examples of a degraded and channelized stream (above) and a healthy stream (below).

the northern 4/5ths of the state, also had HBI values between 5.0 and 6.0. The presence of non-native aquatic insects is not an issue in streams yet. The Asian tiger mosquito now resides in Illinois, but it is not normally a stream species.

CTAP fish biologists monitored 58 sites in 1998 and 1999. The number of native fish species averaged 13.6 (range 1–30). Non-native species and hybrids occasionally thrive under the disturbed conditions characteristic of the state's streams. Currently, 15 non-native species reside in the state, and average only 0.2% of total native species richness. It appeared that the number of non-native species in the usually small drainages sampled by CTAP aquatic biologists was of minor importance. CTAP also utilized fish gathered by IDNR Fisheries and IEPA personnel as part of their five-year rotation through major river basins. Most of these streams were larger than those currently sampled by CTAP and provide a means to evaluate the condition of larger streams. These streams apparently supported a greater percentage of non-native species, but usually less than 3%. The Pecatonica and Des Plaines river basins produced exceptional values, approximating 7 and 8% non-natives as a proportion of native species. The Des Plaines watershed is highly urbanized, while the Pecatonica watershed is dominated by row crop agriculture and a large dairy industry.

RiverWatch volunteers have aided professionals by sampling tremendous numbers of sites, many in multiple years (Table 9). Volunteer data come to much the same conclusion as do the professional data. Total taxa richness averaged 8.9 out of 33 possible taxa, with only 3% of sites providing 15 or more taxa. Statewide, EPT richness averaged 2.6 taxa (range 0–9). This is much lower than reported by professionals because RiverWatch tracks only nine EPT categories. Professionals potentially could encounter any of hundreds of species. A distressing point was that 13% of the more than 1,300 individual samples provided no EPT (e.g., sensitive) taxa, indicating severe degradation.

The Illinois Streams Information System (ISIS) organizes streams into 10 large basins and smaller subunits. The ISIS basins facilitate comparison of geographic trends in CTAP stream data (Table 10). The availability of several aquatic indicators and indices demonstrates that they do not always agree. No ISIS basins scored high on all indicators. The Spoon River, for example, scored high in all measures of macroinvertebrate diversity and pollution tolerance, meaning a diverse macroinvertebrate community of pollution-intolerant species typified the streams in the watershed. On the other hand, the watershed displayed only average habitat quality and below-average fish diversity. The Embarras/Vermilion South watershed supported both diverse macroinvertebrate and fish communities, but poor HBI and MBI values. This suggested that the species, however diverse, tolerated moderate levels of organic pollution. Several watersheds scored at or

Table 9. Number of streams and sites monitored by RiverWatch in 10 Illinois Streams Information System basins. *This includes streams >10 mi^2—RiverWatch volunteers sometimes monitor smaller streams.

Streams in ISIS basins*	1995 Streams/ Sites	1996 Streams/ Sites	1997 Streams/ Sites	1998 Streams/ Sites	1999 Streams/ Sites	Total Streams/ Sites
1587	96/107	216/249	234/288	259/337	270/341	447/580

Table 10. Basins with notably better or worse indicator values relative to the average. Blank cells indicate values near the average, '+' indicates greater than 1/2 standard deviation above the average, '-' indicates more than 1/2 standard deviation below the average.

ISIS Basin	HBI	MBI	EPT Richness	Taxa (RW)	EPT Taxa Richness	Taxa Dominance	Native Fish	Darter Richness	Exotic Species	Habitat Score
Rock	-	+							-	-
Fox/Des Plaines		-			-				-	+
Kankakee/ Vermilion/ Mackinaw	+	-	+	+	+				-	-
Spoon	+	+	+	+	+	+	-		+	
Sangamon		+	+				-	+	+	+
La Moine						-	-	-	+	+
Kaskaskia		-	-	-	-	-	-	-	-	-
Embarras/ Vermilion	-	-	+	+	+		+	+	+	
Little Wabash	+	-		-	-	-	+	+	+	+
Big Muddy/ Saline/ Cache	-	+		+	+	+	+		-	

below the average for most indicators. These included the Rock, Fox/ Des Plaines, and La Moine basins. One watershed, the Kaskaskia, scored consistently low on virtually every indicator.

In a couple of instances, the volunteer and professional data seemed contradictory. For example, professionals and volunteers came to vastly different conclusions about the Little Wabash basin, but so few sites were sampled by each that no valid comparison could be made. In the Big Muddy / Saline /Cache, professionals reported below-average conditions, reflecting the intensively farmed nature of the randomly selected sites. Volunteers mostly monitored attractive streams in upland areas of the Shawnee National Forest, an area of the state in relatively pristine condition. CTAP expects these discrepancies to diminish with the addition of random RiverWatch locations. Recent joint quality control efforts involving RiverWatch volunteers and professional aquatic biologists demonstrated that a few areas of improvement in protocols and training are necessary. Importantly, significant and strong correlations (parallels) between some RiverWatch and professional indicators occurred. These indicators will be useful for making broad generalizations about stream condition, and possibly in predicting some of the professional indicators. In this way, one half of the program informs the other and helps CTAP meet the goal of describing the condition of Illinois ecosystems.

Sampling sites are selected using geographic information system and global positioning system technologies.

CONCLUSIONS, DIRECTION, VISION FOR THE PROGRAM, AND THE UPCOMING CTAP-II REPORT

CTAP is a broad-ranging program that includes land-cover mapping, educational activities, production of documents for ecosystem partnerships, and monitoring of ecosystem condition. Every component is supportive of the others and together they provide a holistic look at the state of Illinois ecosystems. Already, the program is able to document land uses from recent satellite data, and update this information as needed. The production of a land-cover atlas in compact disc format, in conjunction with Regional Assessments, gives ecosystem partnerships real tools to answer questions and set priorities for managing their own back yards. Educational programs, either through Plan-it Earth or indirectly through EcoWatch training volunteers, are getting a large number of Illinois citizens involved in understanding the environment around them. With this information they are better equipped to make decisions about the kind of landscape in which the wish to live. Ecosystem partnerships, Plan-it Earth, and EcoWatch have been successful in enfranchising the public to the environmental management decision-making process.

A major accomplishment of CTAP is the institution of standardized, statewide monitoring that permits comparisons across the state and into the future. The program has found several informative trends already. Our ecosystems are degraded, of this there is no doubt. The spread of non-native and invasive species, along with continued habitat fragmentation, appear to be major culprits.

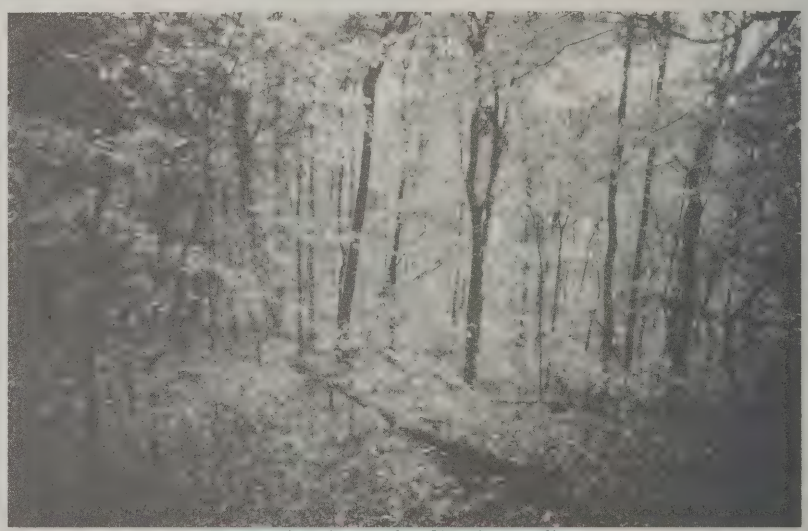
The Ecosystems Program of Conservation 2000 is tackling some of the problems illustrated by CTAP data. It is providing technical and financial support to regional, citizen partnerships that wish to improve conditions in their own back yards. Recently, Marvin Hubbell, head of Conservation 2000, called for partnerships to monitor the effectiveness of habitat improvements supported by the agency's funding. CTAP professional and volunteer protocols are available for this, and with data on statewide and regional averages, standards for monitoring change already exist.

For CTAP to be successful in the future, the reports and data collected now must be used by state government and the citizens of Illinois in planning, management, and policy formation. One obstacle to this is getting the information out to those who need it and in a manner that is easily understood. CTAP is planning to produce a centralized data management system that would meet several goals:

- provide safe storage of both professional and volunteer data
- allow for retrieval of information for the purposes of sophisticated analysis
- run routine analyses
- put out simplified products such as charts, graphs, site photos, and textual descriptions of site conditions
- combine site data with land-cover data in a GIS format
- allow for the integration of quality-checked data from other sources such as that gathered by ecosystem partnerships.

This system would put all but the most sensitive of the hard-earned CTAP data at the fingertips of every Illinois citizen. That act would complete the agreement that government makes with it citizens to be forthright and forthcoming with information it gathers using citizens' tax dollars.

In a few months, an interim report on Phase II of CTAP, *Critical Trends in Illinois Ecosystems*, will become available. It will contain detailed reports of progress on land-cover mapping, regional assessments, educational efforts, and ecosytem monitoring. Included will be detailed discussions of methods used by professionals and volunteers. As a method for regionalizing the discussion of ecosystem condition, a chapter on each ISIS basin will be provided. This document will provide the first statewide assessment of the condition of multiple ecosystems in Illinois. At this point the state will know "where we are" and within a few years will begin to know the "whither we are tending" part of Lincoln's phrase.



Forest site chosen for CTAP sampling.

Authors (in alphabetical order): Stephen D. Bailey (ornithologist), Alice Brandon (Quality Assurance Officer, EcoWatch), Connie J. Carroll (botanist), R. Edward DeWalt (aquatic biologist, and editor of this issue), James L. Ellis (botanist), Rhetta L. Jack (ornithologist), Greg R. Spyreas (botanist), William G. Ruesink (program administrator).

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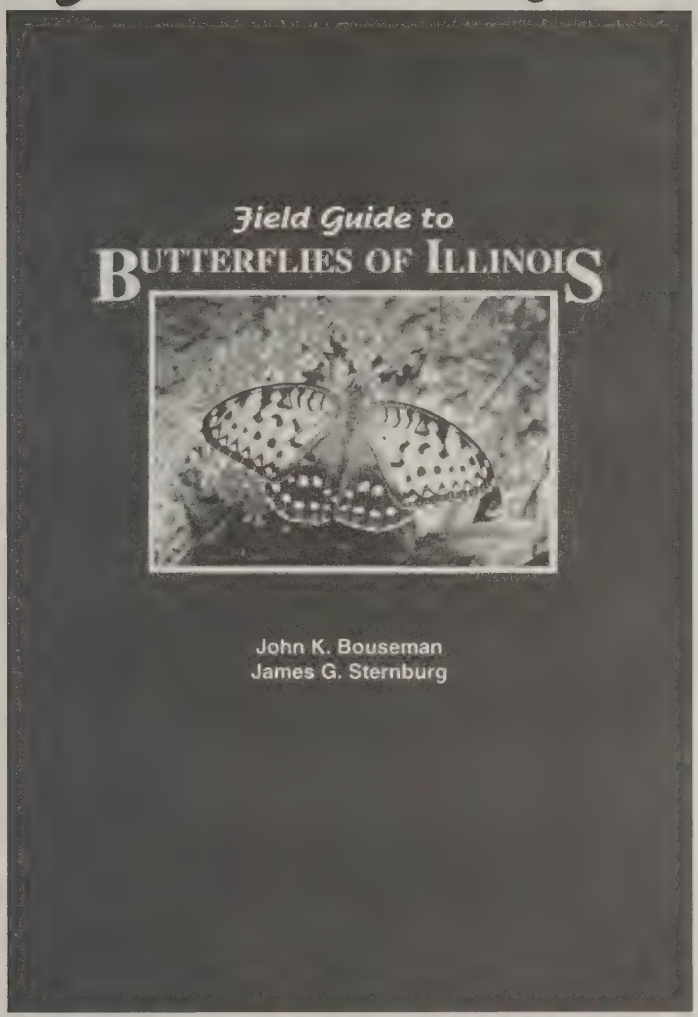
Announcing...



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Species Spotlight

Coyotes

Michelle Garland

Photo by Michael Jeffords, INHS Center for Economic Entomology

"I'm the voice of all the Wildest West, the Patti of the Plains; I'm a wild Wagnerian opera of diabolic strains; I'm a roaring, ranting orchestra with lunatics becrammed; I'm a vocalized tornado – I'm the shrieking of the damned."

– Ernest Thompson Seton, *The Coyote's Song*, 1913

The coyote was considered by some as the voice of the untamed American desert, and it is certainly one of the most vocal of all North American wild mammals. Coyotes, unlike wolves, make barking or yipping noises. Its Latin name, *Canis latrans*, means "barking dog." Thomas Say, who gave the first official zoological description of the coyote, noted, "Their bark is much more distinctly like that of the domestic dog, than of any other animal; in fact the first two or three notes could not be distinguished from the bark of a small terrier, but these notes are succeeded by a lengthened scream." Researchers have identified 11 forms of vocal communication in coyotes. Barking is often associated with territoriality, especially when accompanied by foot scratching. The howl keeps pack members in communication with one another.

Coyotes also rely on nonverbal systems of communication. For example, movement and position of the ears is used to communicate mood and rank. They also make use of an intricate system of scent marking.

The coyote is the most widely distributed large predator in North America. Because of its incredible adaptability, the coyote is presently one of the few mammals whose range is increasing despite increasing human impacts on its habitat. Its range extends from Costa Rica to Alaska and from coast to coast in the United States and Canada. The extermination of the wolf in central and northern America contributed greatly to its range expansion. Originally a native of the American Southwest desert and arid regions of the Midwest, the coyote has adapted to a wide range of habitats including Alaska's North Slope, the mountains of Guatemala, and the forests of New England. The coyote's preferred habitats are meadows, pastures, wooded bluffs, and prairies—any open area in which they can hunt with greatest ease.

Coyotes were present in Illinois before European settlers arrived, and increased in numbers due to the removal of timber. Journals kept by settlers suggest that coyotes (then called prairie wolves) were abundant in Illinois in the early 1800s, but by the mid-1800s the number of coyotes was dwindling. This trend was linked to declining populations of prey caused by habitat loss and overharvest, and organized efforts of humans to eliminate the coyote.

Since European settlement, the coyote has been erroneously blamed for preying on livestock. When ranchers began raising livestock on the American and Canadian prairies in the mid-1800s, coyote eradication programs were formed, which coincided with the elimination of all rivals for western range land, including bison, wolves, and grizzlies. By the late 1800s, millions of coyotes had been killed by trappers, hunters, and ranchers. The eradication attempt is by no means over; in 1992 alone, nearly 100,000 coyotes were killed by government agencies.

Coyotes are beneficial to agricultural cropland because they prey on rabbits and mice, keeping these populations in check. Clever and determined scavengers, coyotes also eat insects, fruits and berries of wild plants, deer, raccoons, birds, fish, carrion, and small domestic animals. Coyotes are now most active from evening to early morning, however they were probably daytime hunters in the past but became more nocturnal due to human activity.

Justifiably, coyotes have grown to be very secretive and wary of humans. They make their dens in concealed spots, usually a burrow in the soil, a hollow between rocks, or in the base of a hollow tree. Sometimes they enlarge an abandoned fox or badger hollow. Dens are usually dug by females, and birth and early pup care is carried out there. Pups are born in early May, leave the den in June, and remain with the mother until fall. Pups depend on food brought by pack members until they learn to hunt for themselves. A coyote pack averages six animals, and at the center of the pack is the mating, or alpha, pair. In general, only the alpha female bears young, a litter typically being six to eight pups.

Eastern subspecies are characterized by a doglike body that resembles a German shepherd in size, conformation, and color, but carries its bushy tail below the level of its back rather than curved upward. Western coyotes are smaller and finely featured, more like large foxes than dogs. Coyotes can breed with domestic dogs and wolves, a dog-coyote mix being called a "coydog." Coyotes are often blamed for damage caused by coydogs.

Considered rare in Illinois as recently as the 1950s, the coyote is now common throughout the state, and is most abundant in southern, southeastern, and west-central parts. The coyote population increased dramatically in the 1970s, and seemed to peak in the mid-1980s. As of 1995, the coyote population in Illinois was estimated at 30,000.

Coyote Word Search

Look through the list of words that pertain to a coyote's life. See how many of them you can find in the block below.

S E I P P U P E E T S T N E D O R
C A N I S L A T R A N S P E R E A
E A R E E D E I R A C A N E G C B
N P R A I R I E W O L F T N O A B
T I G N I L W O Y N I S A T R S I
M Y A I I E C O I E K R T E H E T
A C F P L V T X I C E O S U O D B
R O O P F E O S I M N U N M W W U
K Y K Y L N O R O T O T O I L O R
I D C N O R T H A M E R I C A L R
N O A L W T H I S R E V R E S F O
G G P A E C L A P R A I R I E L W
O S Y I N S E C T S O S A C L O I
D B L C I S K N A B E T C L O W N
S I I I C T A N A H P L A N V H G
D R M R I I E C I M R E E D C S D
O D A T D U Y I P P I N G I E U O
G S F L E R R I U Q S D N U O R G
P E T A M F L O W G N I K R A B P

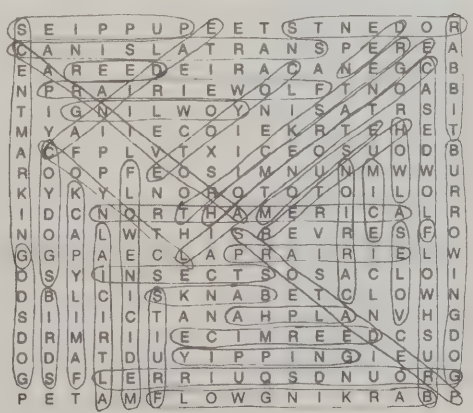
Coyote classification:
CARNIVORA
CANIDAE
CANIS LATRANS

Names for coyotes:
COYOTE
PRAIRIE WOLF
BRUSH WOLF
BARKING WOLF
CASED WOLF
MEDICINE WOLF
TRICKSTER
BURROWING DOG
GOD'S DOG
COYOTL
COYDOGS

Coyote diet:
RABBIT
COTTONTAIL
RODENTS
INSECTS
BIRDS
FRUITS
CARRION
GROUND SQUIRREL
VOLES
DEER MICE
MICE
DEER
MOUSE

Coyote life:
DEN
BANKS
PRAIRIE
FAMILY PACK
PUPPIES
HUNTER
PREDATORS
HOWL
YOWLING
YIPPING
NORTH AMERICA
ALPHA
ALTRICIAL
HOME RANGE
SCENT MARKING

Answers



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CTAP Update

continued from front page

• The development of a Web-based information delivery system, the Illinois Natural Resources Information Network (INRIN, http://dnr.state.il.us/orep/inrin/ctap/), that provides the public, land managers, and municipalities with an easy and informative way to gather data on their own back yards.

This special issue of *INHS Reports* focuses on the new monitoring data collected by professionals and volunteers. However, all its components are indispensable to the overall mission of CTAP and help to inform the direction that the program will assume in coming years. This issue will briefly discuss these other components as well. These new data will inform land managers, policy makers, and the public about the condition of the state's ecosystems. Already, some trends in condition have emerged. For instance, CTAP has demonstrated that introduced species are abundant inhabitants of Illinois' terrestrial ecosystems, with wetlands and grasslands in the northern third of the state being heavily affected. This knowledge, in standardized, statewide format, will direct additional research on the reasons for this trend, could point to effective restoration techniques, and provide a scale for measuring improvement. For more on CTAP set your browser to the INRIN site above.

CTAP researcher Jamie Ellis collects voucher specimens for the INHS herbarium.

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ILLINOIS NATURAL HISTORY SURVEY

Reports

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INSIDE

Rob Wiedenmann (L) with INHS Chief David Thomas at purple loosestrife workshop.
Photo by Michael Jeffords, INHS Center for Economic Entomology

Exotic Species Education and Outreach

Charles Helm, INHS entomologist, leads outdoor workshop.
Photo by Michael Jeffords, INHS Center for Economic Entomology

Exotic, invasive species are major ecological and economic threats to the natural and agricultural ecosystems of Illinois, the nation, and the world. For example, nearly 1,500 trees have been lost to the Asian longhorned beetle in the Chicago area, garlic mustard is choking out woodland wildflowers throughout the state, zebra mussels are wreaking havoc in the Great Lakes, and the impact of the recently detected soybean aphid is yet to be determined. While INHS scientists are involved in both basic and applied studies to assess the ever-increasing threat of such exotic invaders, an equally important component of this ongoing battle is public information and education. In the case of the Asian longhorned beetle in Chicago, intense media coverage and public awareness campaigns undoubtedly helped the public to identify additional infestations outside of the original quarantine areas and to better understand that tree removal, no matter how distasteful, provided the best opportunity to limit the establishment and spread of this pest.

The Office of Outreach and Education of the Illinois Natural History Survey has a wide variety of educational materials and programs available to the citizens of Illinois and it has also developed several educational activities that target elementary, middle school, and high school teachers and students. Exotic species educational and outreach efforts are an integral part of these programs.

Calendar

The full-color 2001 wall calendar "Exotic, Invasive Species of Illinois" is aimed at raising awareness of the overall problem of exotic species and acquainting citizens with a few of the more serious invaders of the Illinois landscape. Each month of the calendar features a photograph and description of a problem invader and important dates concerning exotic species. Nearly 3,000 copies of this calendar have been distributed to local, state, and federal agencies and to middle school and high school science teachers.

Posters

The gypsy moth continues to threaten trees in northeastern Illinois, resulting in a quarantine of Lake County in August 2000. Because of the potential for inadvertent movement of gypsy moth egg masses by the public from infested to noninfested areas, a poster was developed to alert the public to check vehicles and outdoor articles if they have recently visited regions of known infestations. With the cooperation of the Illinois Departments of Agriculture and Transportation, these posters have been placed in visitor centers, rest areas, and other facilities frequented by the traveling public.

Fact Sheets and Displays

One-page Insect Info fact sheets have been developed for several other species, including the Asian longhorned beetle and Asian tiger mosquito. A more detailed, multi-panel photo and text display chronicles the entire Asian longhorned beetle saga, from the situation in China and its route of infestation to its cur-

Continued on back page

Fruit Complementarity in Feeding Birds

As any home owner trying to raise raspberries or blackberries for personal consumption can attest, many bird species are also avid consumers of fruit. Careful observation of the foraging or feeding behavior of a particular bird often reveals that diet selection of fruiting birds tends to be quite diverse, even within a particular day. There are theoretical reasons to be surprised by such observations. Consider the following facts:

- Many plant species produce huge standing crops of fruits that often ripen more or less synchronously, resulting in a large and concentrated food resource. In addition, fruits of many species are conspicuously colored, making their discovery by potential consumers relatively easy.
- Based on gross nutritional reward (chemical composition of the pulp), we know that fruits of different species differ in such characteristics as energy reward per unit fruit mass dry weight. This in turn allows an a priori ranking of suitability as an energy source, in decreasing order from greatest to least energy per unit fruit mass.
- In temperate regions, like Illinois, many plant species seem to ripen their fruit to coincide with the mass movement of autumnal migrants. Migration is obviously an energetically costly activity, when energy reward from food would seemingly be at a premium.
- Standard theoretical models of foraging predict that inclusion of an item in the diet is dependent only on the abundance of the highest ranked item currently available. If it is above a certain threshold of abundance, it should be selected exclusively.

Taken together, the above facts suggest that specialization, not generalization, in fruit selection should be the norm and not the exception. So why is generalization so pervasive?

Before tackling that question, what actually is the scientific evidence that specialization on single fruit species diets is in fact uncommon? Studies reporting on diet selection of fruit-consuming "frugivorous" birds fall into a number of categories. One method consists of examining the gut contents of birds. This can be done in any one of three ways: 1) by sacrificing the animal, removing the gastrointestinal tract, and removing and examining the digesta; 2) by using an emetic—a solution that induces the recipient to vomit—and collecting the regurgitated items; 3) by collecting and examining fecal matter. A second method consists of following an individual bird and recording its behaviors and the foods it consumes, usually in serial order. A third method of studying diet selection consists of experimentally offering either captive or free-ranging birds a variety of fruits from which to select and recording the results. Evidence from all three methods of analysis suggests that diet generalization is the norm in birds.

The issue first struck me when analyzing results of field experiments conducted as a postdoctoral associate of Mary F. Willson, then in the Department of Ecology, Ethology, and Evolution at the University of Illinois at Urbana-Champaign. In our experiments we offered free-ranging, autumnal migratory songbirds natural fruits on artificial fruit displays. These displays (bamboo skewers with double-sided sticky tape or wood doweling with metal hooks to which fruit were attached) allowed us to control various aspects about how birds would naturally encounter fruits. In one experiment, we offered birds fruits of plant species that we knew differed in gross nutritional rewards. We expected that the migratory birds eating these fruits would preferentially select those high in lipids (fats) because of their greater "bang for the buck." Instead, we detected clear preferences for some fruiting species over others, but not in a way easily explained by gross nutritional reward. One clue to such complex foraging patterns may lie in the nutritional relationship that fruits of different plant species represent to bird consumers. Specifically, if fruits of different plant species represent "complementary" resources (resources for which joint consumption results in greater reward than consumption of an equal amount of either resource singly), we would predict that fruit specialization would be rare. This result, in turn, would suggest that such resource complementarity

The Scarlet Tanager, a typical fruit-eating bird in Illinois. **Photo by Michael Jeffords, INHS Center for Economic Entomology**

Continued on page 5

Applying Geographic Information Systems Technology to the Ecological Risk Assessment Process in Illinois

An ecological risk assessment involves examining the impacts of environmental hazards (e.g., oil spills) in and around the area where a release occurs. Conducting this assessment requires information on the occurrence and distribution of natural resources. Knowledge of the distribution of a species relative to the site of release/contamination can facilitate the evaluation of the impacts of contaminated locations by allowing a rapid ecoscreening in the event of a toxic release.

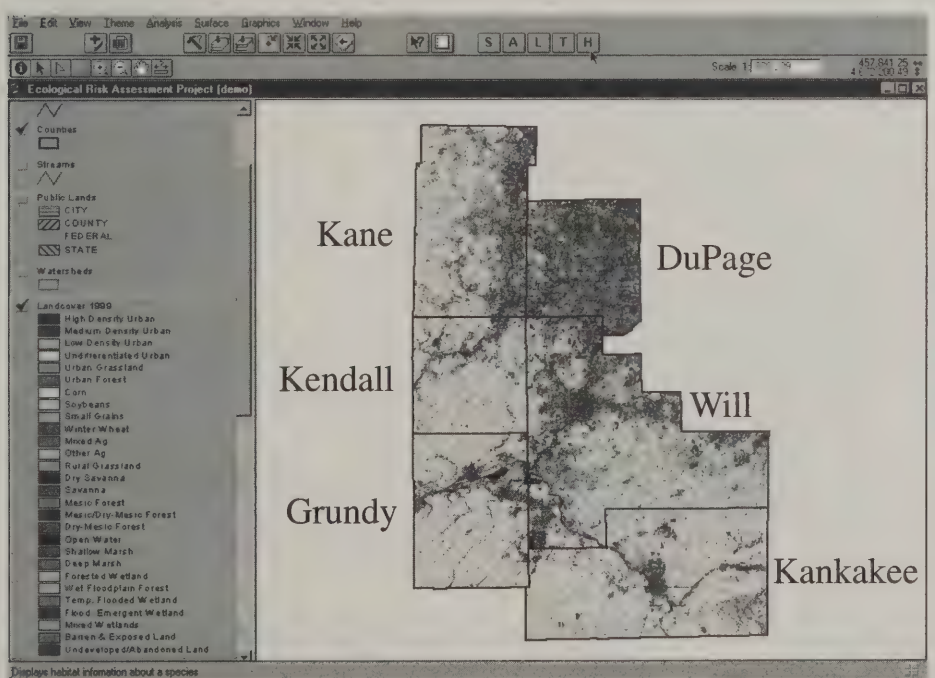
For this pilot project, we gathered data from a variety of sources to create a comprehensive database of species occurrences and their susceptibility to environmental contaminants. We selected several terrestrial and aquatic species, such as the American Kestrel, the mink, and the fantail darter. We chose these species for our pilot project based on expert opinion, availability of data sets, and whether they are good indicators of environmental contamination. We included both those species that prefer specific habitats (specialists) as well as others that prefer a wide variety of habitats (generalists).

The project locations are in DuPage, Grundy, Kankakee, Kane, Kendall, and Will counties of northeastern Illinois. We chose this area because it is undergoing rapid urban development that may increase the need for ecological risk assessments. Parts of these counties represent an expanding suburban/rural interface where human and wildlife interactions are intensified. Additionally, this area includes important natural areas, such as Midewin Tallgrass Prairie, Goose Lake Prairie State Natural Area, and Des Plaines Conservation Area, as well as portions of the Fox, Illinois, and Kankakee River watersheds.

We began by building a database of species locations using data associated with scientific collections, such as those located at the Illinois Natural History Survey, and from a variety of other sources such as wildlife surveys and bird banding records. Also, we determined the preferred habitats in our research area for each species by researching scientific literature. Concurrently, we classified satellite imagery from spring, summer, and fall dates in 1999 into vegetation types within our project area. The habitats preferred by each species were then assigned to the corresponding vegetation types in order to determine a predicted distribution for each species. The point locations were used as an accuracy assessment for each predicted distribution.

In developing our ecoscreening tool, we created a computer interface using geographic information system (GIS) technology. The interface can be used with ArcView 3.2 (ESRI 1999), and includes the predicted distributions of our selected species within northeastern Illinois. We also incorporated characterizations of a species' relative susceptibility to contaminants, as well as other relevant spatial databases, such as Illinois vegetative classifications, public lands, streams, watershed basins, major interstates, roads, and topographic maps. This pilot project applies data collected as part of the Illinois Gap Analysis Project to ecological risk assessment (see http://www.inhs.uiuc.edu/cwe/gap/gapintro.html for more information).

Continued on page 5



When initially opening the program, a user views the six-county region of Illinois with the vegetation classification layer. The various map layers, such as watersheds and streams, listed on the left part of the screen may be activated and viewed along with the vegetation layer.

Physiological Telemetry in Fisheries Research

For over 50 years, radio and ultrasonic telemetry devices have been implanted in or attached to fish to document their distribution and movement. More recently, telemetry devices have been developed that use external sensors to provide information (e.g., depth, water temperature, pH, salinity) on the environment that fish are inhabiting. The ability to measure these environmental variables is important for understanding habitat use and preferences; however, they provide little information on how or why these fish respond as they do, either behaviorally or physiologically, to their environment.

Interest in exploring the energetic consequences and mechanistic basis of fish distribution and movement has fueled the rapid development of a variety of physiological telemetry devices (e.g., those that measure locomotory activity or heart rate) that are proving to be useful for basic and applied fisheries research. The largest benefits from physiological telemetry arise from the ability to continuously monitor behavioral and/or physiological attributes of free-swimming fish. Thus, we can release fish into natural environments and monitor their response to different stressors in situ and in real time. In this article, we review the broad range of applications for which we have utilized physiological telemetry devices to answer pressing fisheries questions.

One of the applied research areas that has benefited from physiological telemetry is the assessment of the true impacts of catch-and-release angling. Using locomotory activity transmitters, we have monitored the response of nesting male largemouth bass to angling, and have documented an impairment in their ability to provide parental care following this disturbance. We have also used activity transmitters to assess the effects of live-well density on the behavior of smallmouth bass. More recently, we have also begun field testing heart rate telemetry devices and have successfully monitored cardiac activity before, during, and after angling (Fig. 1). This approach to assessing the impacts of catch-and-release angling will permit the identification of those practices that are detrimental to fish and will provide much needed information on the sublethal effects of different angling and handling practices. A key focus area for future research is a comparative study of how various sportfish species that often are released—both freshwater (e.g., muskellunge and trout) and saltwater (e.g., bonefish and tarpon)—respond to angling stress.

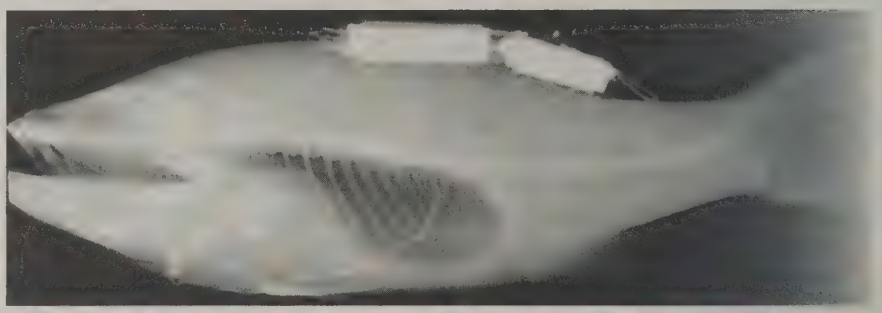


Figure 1. Radiograph of an adult largemouth bass equipped with an ultrasonic heart rate transmitter.

Knowledge of the activity and metabolic rates of fish is also important in the development and application of bioenergetics models for managing fisheries. Physiological telemetry has permitted the refinement of energetics models by providing empirical data on the inherently difficult-to-monitor respiration components of the models. Using forced swimming trials in a respirometer, relationships can be developed between different telemetered data (e.g., locomotory activity or heart rate) and both swimming speed and oxygen consumption (Fig. 2). These calibrations can be used to estimate the metabolic rates of free-swimming fish in the field (i.e., estimating oxygen consumption from changes in heart rate or locomotory activity). Furthermore, we can use the relationship between locomotory activity and swimming speed to estimate the distance traveled by individual fish. Using this approach, we have determined that for smallmouth bass, significant energy can be expended undertaking fine-scale, localized movements, a finding that would be undetectable using conventional locational telemetry. We have also examined the physical activity associated with largemouth bass spawning, quantified and compared the energetic cost of parental care activity of male smallmouth bass and largemouth bass, and we are in the process of developing gender-specific seasonal energetics budgets for both of these species.

Figure 2. Respirometers are used to calibrate physiological telemetry devices. Here, INHS technician Kate Deters and graduate student Steven Cooke swim a smallmouth bass while monitoring its heart rate and oxygen consumption.

In addition to the uses described here, physiological telemetry is also an effective tool for studying migration energetics, determining areas of difficulty associated with the use of fish passage devices, assessing fish responses to thermal stress (i.e., winter ecology, thermal effluents), and in developing welfare correlates in aquaculture operations. We feel that the continued development and refinement of physiological telemetry devices will facilitate the collection of information that would otherwise be unattainable. For example, by merging the use of physiological telemetry with molecular genetic techniques, we hope to assess how evolutionary divergence over time translates into the meaningful biological differences that serve as the basis for adaptation and ultimately, speciation.

Steven J. Cooke, David H. Wahl, and David P. Philipp, Center for Aquatic Ecology

Fruit Complementarity

continued from page 2

needs to be accounted for in theoretical models of diet selection.

To test this hypothesis, I and several colleagues conducted field experiments in 1993 and 1994 at The Morton Arboretum in Lisle, Illinois. The arboretum is an ideal site for such a test because of the large number and variety of fruiting species that are grown throughout its 1,600 acres. In the experiments, we compared the consumption of fruits from artificial displays that occurred in each of two foraging backgrounds, which consisted of fruiting plants of the species being compared. In each background, the "home" fruit is superabundant, while the "foreign" fruit is rare. Given this foraging scenario, if the species of fruit under comparison are complementary, each should be relatively more preferred when "foreign" than when "home." This is precisely what we found in 10 out of 12 comparisons, a result not expected by chance. Although our results do not address the underlying cause of complementarity, there is growing evidence to suggest it may result from toxins that occur in the pulp of many plant species.

What is the significance of such findings? For one, such resource complementarity suggests that the extent of feeding on the fruit of a given plant species may be at least partially dependent on what other fruits occur in its general vicinity. This in turn will affect patterns of movement of bird consumers, and consequently, patterns of seed deposition. In this way, complementarity could play a role in plant dispersal, succession, and even invasion by exotic species, like the bush honeysuckles, whose fruit are eaten by birds. More practically, the results may suggest ways to increase fruit consumption in projects like ecological restorations, or to decrease fruit consumption in agricultural settings.

Christopher J. Whelan, Center for Biodiversity

Ecological Risk Assessment

continued from page 3

Our GIS interface incorporates predicted species distributions and other spatial database layers as well as toxicological profiles and species' habitat associations to enhance the process of ecological risk screening. Additional spatial data, such as the location of contaminated areas, can be added into the interface. Our database is more informative, encompassing, and efficient than what is currently available for initial ecological screening. The expansion of the pilot project to include additional species and other geographic regions would allow for greater protection of Illinois' natural resources. Similarly, the development of additional applications would expand the utility to natural resource professionals.

Shana Lavin, Tari Weicherding, Jeff Levengood, and Jocelyn Aycrigg, Center for Wildlife Ecology

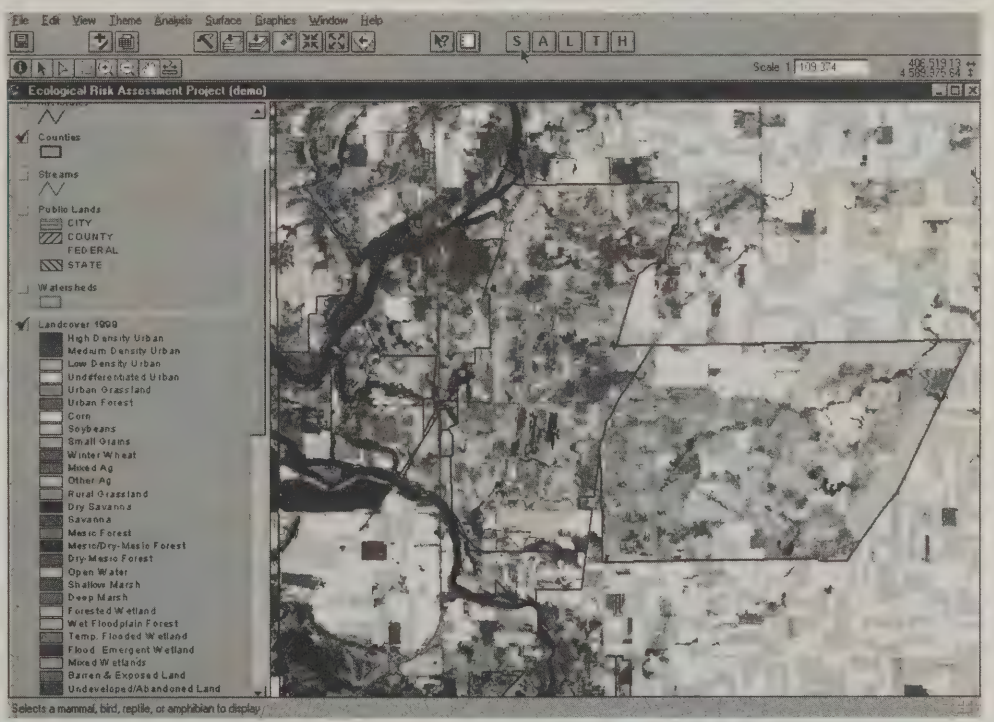


Image of a zoomed-in screen capture with species distribution. The interface allows the user to zoom into a specific area, for example, Midewin Tallgrass Prairie, and view a particular species distribution. In this case, the blackened area represents the distribution of the mink. Alternatively, a user can select a region, and those species with predicted distributions in the area will be identified.

ILLINOIS WILDS INSTITUTE FOR NATURE

Exploring the Nature of Illinois

A Joint Project of the Illinois Natural History Survey and the University of Illinois Department of Natural Resources and Environmental Sciences

SUMMER 2001 CLASS SCHEDULE

THE BUTTERFLIES OF ILLINOIS

Come and join Illinois butterfly authorities John Bouseman, Illinois Natural History Survey, and Dr. James Sternburg, professor emeritus, University of Illinois, for a unique three-day workshop on Illinois' most colorful and fascinating inhabitants. Bouseman and Sternburg are the authors of the new book *Field Guide to Butterflies of Illinois*. Together, they have over 130 years of experience studying Illinois butterflies! Class size is limited to 25 participants.

WHERE: The course will be offered at the Richardson Wildlife Foundation near Amboy, Lee County, in north-central Illinois. Access to this private site is by permission only and provides a great setting for the course. Dozens of Illinois butterfly species thrive in its varied habitats. Participants will stay at various motels within a short driving distance of the site.

WHEN: June 19–21, 2001. The course will begin with lunch at noon on June 19 and conclude around 3 pm on June 21.

COURSE DESCRIPTION: The course will be a mix of classroom and field experiences with two of Illinois' most knowledgeable butterfly experts. Students will learn how to identify Illinois butterflies, study their life cycles, explore butterfly behavior, learn how to properly curate and maintain a butterfly collection (optional), and explore the fascinating topic of mimicry. All field trips are within a short walk of the classroom building. Additional topics to be covered include butterfly photography and how to use butterflies as a measure of habitat quality.

Participants will receive as part of their materials a good-quality butterfly net, a signed copy of *Field Guide to Butterflies of Illinois*, numerous handouts, and other materials. Meals provided include lunch and dinner on Tuesday, June 19; lunch and dinner on Wednesday, June 20; and lunch on Thursday, June 21. Snacks and drinks will be provided during all breaks.

Participants should come prepared to spend considerable time in the field as well as in the classroom. The maximum walking distance during field trips will be approximately 1/2 to 3/4 of a mile. Evening classes are scheduled for both June 19 and 20.

COST: Tuition for the course is $175 and includes all course materials, the meals described above, and snacks. Breakfasts are on your own, as are lodging costs at nearby motels. A list of motels in the $45 to $65 per night range will be forwarded upon registration. Room arrangements are the registrant's responsibility and will not be made by IWIN staff.

REGISTRATIONS WILL BE ACCEPTED UNTIL JUNE 1 OR UNTIL THE COURSE IS FULL, SO REGISTER EARLY!

To register for the above class, or if you have any questions, call Susan L. Post at 217-493-9959, or leave a message on voice mail at 217-333-6659. You may also register by e-mail at the following address: spost@mail.inhs.uiuc.edu.

If you are interested in being on the **IWIN mailing list** for courses offered, please fill out and return this portion to:

Susan L. Post, Registrar
Illinois Natural History Survey
607 East Peabody Drive
Champaign, IL 61820

NAME _____

ORGANIZATION _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PHONE AND/OR FAX _____

E-MAIL _____

PLEASE KEEP ME NOTIFIED OF ALL IWIN COURSE OFFERINGS.

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A new poster series from the Illinois Natural History Survey with color photography by Michael R. Jeffords & Susan L. Post featuring Illinois landscapes and species.

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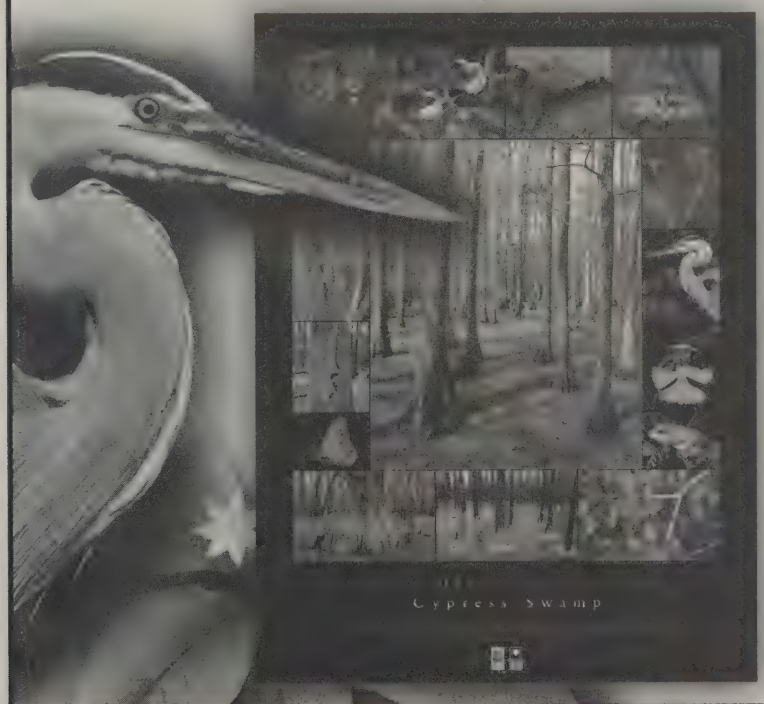

New! No. 2 Northern Bog

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Education Outreach

continued from front page

rent distribution and damage and the eradication efforts in Chicago. This has provided important background information during large-audience presentations but is also appropriate as a stand-alone display for use in nature centers or other public facilities. Nearly a dozen are on display in a variety of city, state, and federal offices in the Chicago metropolitan area and at O'Hare International Airport.

Workshops

Purple loosestrife is an invasive European weed that thrives in wetlands and is particularly abundant in the northern third of Illinois. This exotic weed has provided an ideal educational opportunity to inform the public not only of its threat to the biodiversity of the region but also of a partnership program among INHS researchers, land managers, administrators, and scientists from a variety of organizations. Through this program, teachers and students are now involved in efforts to lessen the impact of loosestrife on Illinois wetlands. In 1998, curricular materials on biodiversity, wetlands, and biological control were developed using purple loosestrife as a case study. During all-day workshops, educators and other interested resource persons are trained using written materials, classroom exercises, experiments, slide sets, and videos. Graduates of these sessions also receive kits containing all the materials needed to rear beetles for release as biological control agents against purple loosestrife. To date, over 100 educators have taken the story of purple loosestrife, from invasion to eventual control, to their students. The success of this program makes it very adaptable to similar outreach efforts on other exotic species. Using the loosestrife case study as a template, comparable units will soon be developed emphasizing the impact of exotics and their potential control in other habitats; for instance, gypsy moths and Asian longhorned beetles in woodlands and urban forests.

Public awareness is the key to both the early detection of exotic invaders and the success of programs aimed at controlling their spread. Invasive species will continue to be an unwanted part of our landscape for years to come, but increased awareness and understanding by government administrators and decision makers, resource managers and users, and the public at large may constitute our best chance of managing this complex problem.

Charles Helm and Michelle Garland, Center for Economic Entomology and Carolyn Nixon and Michael Jeffords, Office of the Chief

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ILLINOIS NATURAL HISTORY SURVEY

Reports

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Summer 2001
No. 368

INHS Inventories Smoky Mountains Flora

If you are ever hiking the trails down at the Great Smoky Mountains National Park (GSMNP), you may stumble across a rag-tag group of botanists from the Illinois Natural History Survey (INHS). Now why would a group of botanists from Illinois be collecting plants down there among the Appalachian Mountains? Because they would be participating in the largest All Taxa Biodiversity Inventory (ATBI) ever to be undertaken on our planet—the All Taxa Biodiversity Inventory of the Great Smoky Mountains National Park.

The goal of an ATBI is to discover and document all the species that occur in a specific area. The idea is that if you know what lives in an area, you will be able to make better decisions concerning the management of the area and monitor changes over time. The GSMNP was chosen as a site for an ATBI because of the rich and diverse collection of plants and animals that occur there, and because of its topography, climate, and size. The park encompasses over half a million acres that include large tracts of old growth and contiguous forests. It has been designated as an International Biosphere Reserve.

The ATBI was begun in the park in 1999 with a deadline of 10–15 years. During this time, the goal of the organizers is to have a comprehensive checklist of all life forms in the park, range maps for each park species, and natural history information for each species. They would also like to have this information organized and available to scientists, educators, land managers, and anyone else who might find it useful via the World Wide Web and other media.

INHS staff (from left) Greg Spyreas, Connie Carroll, Rick Phillippe, and Mary Ann Feist prepare for a day of collecting in the Great Smoky Mountains National Park. **Photo by Dan Busemeyer, INHS Center for Wildlife Ecology**

Because the National Park Service could not hope to complete this grand-scale project on its own within the given time frame, it has called on many partners from universities and colleges, museums, other government agencies, and volunteers to help. The University of Tennessee in Knoxville (UT) was one of the first to get involved. Rick Phillippe, a botanist at the INHS, had done his doctoral work at UT and still had ties to the Botany Department there. When he heard of the ATBI he immediately wanted to become involved. Not only had Rick done his doctoral work in Tennessee, but he also had been going to the park every year for almost 20 years to lead wildflower hikes for the Smoky Mountains Wildflower Pilgrimage. He was very familiar with the flora of the Smoky Mountains and was the perfect candidate to help with the inventory.

That first year (1999) Rick didn't have too much trouble convincing a couple of fellow botanists to go along. Hiking, camping, and collecting plants in the Appalachian Mountains sounded like a good time to Rick

Continued on page 2

INSIDE

The brilliant scarlet-colored fire pink, *Silene virginica*. **Photo by Connie Carroll, INHS CTAP Group**

Flora Inventory

continued from front page

Larimore and myself. Little did we know what lay ahead! Walking the flat lands of central Illinois did little to prepare us for the steep, arduous slopes of the mountains of Tennessee and North Carolina. And we hadn't realized what a single-minded collecting machine Rick Phillippe was. It was hiking from dawn to dusk, up and down the sides of the mountains, both on trail and off-trail, through rhododendron thickets and patches of plants aptly called dog hobble and witch hobble! Despite the experience being a whole lot more like work and less like a stroll in the woods then we expected, the beauty and richness of the place had us hooked.

Mary Ann Feist of INHS presses plant specimens for the All Taxa Biodiversity Inventory of the Smoky Mountains. **Photo by Brenda Molano-Flores, INHS CTAP Group**

The first year we collected 284 vascular plants and 70 lichens including a federally endangered lichen. Word of our exploits spread and more INHS botanists wanted to get involved. Dan Busemeyer, Connie Carroll, and Brenda Molano-Flores began participating in 2000 and Greg Spyreas came along for the first trip in 2001. In the year 2000, we collected 717 vascular plants and 43 lichens including 9 rare plants. In 2001, with just one trip thus far, we have collected over 200 vascular plants including 11 plants rare to the park. These include *Disporum maculatum* (nodding mandarin), *Trillium cuneatum* (bloody butcher), *Hexastylis shuttleworthii* (large-flowered heartleaf), and Rick Phillippe's personal favorite, *Sanicula smallii* (southern sanicle)! Many of these rare plants were not known from the locations where we collected them.

Although the vascular plants are fairly well known for the park in terms of a checklist, the distribution and abundance of many plants is not known. To help with this, we focus on a specific watershed and collect everything we can within it. We always try to collect two specimens of each species. One of these goes to the GSMNP collection at UT and one is deposited into our herbarium at INHS. These specimens are valuable for our herbarium. As it turns out, many species rare in Illinois are much more common in the Smoky Mountains. If not for our collections made in the park, we might have only a few or no specimens of these species in our herbarium. Examples of such plants include *Euonymous americanus* (American strawberry bush), *Chimaphila maculata* (spotted wintergreen), *Gaultheria procumbens* (wintergreen), *Polygonatum pubescens* (downy Solomon's seal), and *Carex nigromarginata* (black-edged sedge), which are Illinois state endangered species, and *Carex prasina* (drooping sedge), which is an Illinois state threatened species.

The ATBI of the GSMNP is a long-term project and we hope to continue our participation for several more years. This project is important because of the information it will provide and because a scientific survey of this scale has never been undertaken before. It will serve as a model for future projects in other parks and protected areas, perhaps someday in the state of Illinois.

Mary Ann Feist, Center for Wildlife Ecology

Watershed site chosen for specimen sampling in the Smoky Mountains. **Photo by Dan Busemeyer, INHS Center for Wildlife Ecology**

Introduced into North America in 1869, the gypsy moth has radiated west and south from its release site in the Boston area to 17 states and the District of Columbia. The current line of infestation extends over 1,200 miles from Wisconsin to North Carolina, including northern counties in Illinois and Indiana (Fig. 1). The gypsy moth is an "outbreak species"; in infested areas the populations build up over a period of years, peak in very high densities, then decline strongly in the presence of natural enemies such as parasites and diseases. In years when populations of the pest are high, oaks, willows, aspens, and other forest trees may be completely defoliated by the larvae over large areas. The resulting stress to trees due to 2–3 years of defoliation, added to other stresses such as drought or the urban environment, may kill the trees, sometimes in large tracts. Damage by gypsy moth larvae varies according to the level and extent of outbreaks but costs are millions of dollars per year.

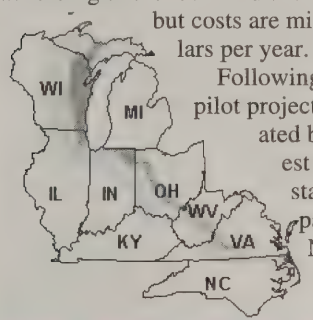

Figure 1. Spread of the gypsy moth. Dark area is the transition zone, the light area west and south is the "leading edge" of advancement. All susceptible areas north and east of the transition area are generally infested. **Graphic courtesy A. Sharov, http:/ www.ento.vt.edu.STS/**

Following a successful pilot project that was initiated by the U.S. Forest Service and state and federal partners, the National Gypsy Moth Slow the Spread (STS) Project was instituted in 1999. Illinois joined this program, which merges the efforts of states and federal agencies, to reduce damage and slow the inexorable spread of the gypsy moth. Newly invaded territory has been reduced by over 9,000 square miles annually, saving a minimum of $22 million in lost timber and recreational land use per year nationally.

The STS Project is designed to address the gypsy moth invasion at the "leading edge" of its spread while suppressing outbreaks in generally infested areas. All habitats in the U.S. that are susceptible to invasion are divided into three zones: the infested zone, the transition zone, and the uninfested zone (Fig. 2). Infested zones are typically treated under suppression program guidelines with *Bacillus thuringiensis kurstaki* (*Btk*), a bacterium specific to moth larvae, diflubenzuron, an insect growth inhibitor, or Gypcheck®, a gypsy moth-specific virus, where outbreaks occur. In addition, natural enemies of the gypsy moth are manipulated to dampen the outbreaks in these areas.

Under the STS Project, a major management effort takes place in the transition zone. Intensive monitoring using pheromone-baited traps for adult male moths is conducted in these areas and decisions about treatment are made based on trap counts. Trapped males are counted periodically during the flight season to estimate the population density of the pest. July 10–25 is peak flight season in Illinois. Growing gypsy moth populations are treated using different methods depending on the extent and isolation of outbreaks, sensitivity of the environment, and other parameters. A general outbreak in a suburban area, for example, may be treated with *Btk*, an insecticide that is not harmful to vertebrate animals, including humans. A very sensitive area, such as a wildlife refuge, might be treated with pheromone flakes to disrupt the mating of gypsy moths, a method that does not affect other animals, including insects.

The gypsy moth typically does not spread in a steady progression from the generally infested areas to uninfested areas; instead, it occurs in isolated outbreaks in the transition zone. These outbreaks usually occur because of human transportation of egg masses or pupae that "hitch a ride" on transported items such as vehicles, outdoor recreational equipment, and nursery stock. One method for reducing this kind of spread is to quarantine generally infested areas with high or growing gypsy moth populations that are adjacent to transition areas. In Illinois, Lake County was quarantined in 2000. Under quarantine, nursery plant stock is inspected before shipment out of the county for presence of any life stage of the gypsy moth. Citizens moving from the area should contact officials regarding the movement of vehicles and any other property stored outdoors that may serve as egg-laying or pupation sites.

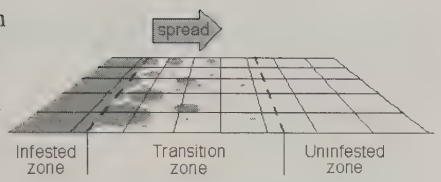

Figure 2. Spread of gypsy moth from generally infested zones to uninfested zones. Intensive monitoring locates new outbreaks in the transition zone. **Graphic courtesy A. Sharov, http:/www.ento.vt.edu.STS/**

Gypsy moth numbers are increasing in Illinois, setting the stage for further spread. Outbreaks are expected to increase in 2001 and treated areas in the transition zone include areas in DuPage, McHenry, and Winnebago counties where overwintering egg masses have been located. Twenty-one counties in northern Illinois are being monitored under the STS Program and most other counties in the state are being monitored by the U.S. Forest Service, USDA Animal Plant Health Inspection Service, and state cooperators.

Scientists in the Illinois Natural History Survey (INHS) Center for Economic Entomology and Illinois Department of Agriculture are monitoring gypsy moth populations for presence of naturally occurring disease organisms and have found that a very host-specific and virulent fungal pathogen occurred in gypsy moth populations in McHenry County in 2000. Other investigations are being conducted by INHS in cooperation with the U.S. Forest Service on the effects of a group of natural pathogens, the microsporidia, that occur in European gypsy moth populations but not in North American populations. Several Web sites are excellent sources of information about the STS Program, both advisory and technical, regarding the decision-making process for monitoring and treatment of gypsy moth infestations. Included are:

- http://www.ento.vt.edu/STS/
- http://www.fs.fed.us/na/briefs/sts00/sts00.ht http://www.aphis.usda.gov/oa/pubs/fsspread.html
- http://www.urbanext.uiuc.edu/greenline/00v5/01.html
- http://www.agr.state.il.us (Quarantine text)

Leellen Solter and Charles Helm, Center for Economic Entomology and James Cavanaugh, Illinois Department of Agriculture

Changes in the Pollinator Guild of a Prairie Species in the Past 70 Years

Pollinators are an essential part of the reproductive biology of plants. In most cases, more than one pollinator is associated with a species. Pollinator guild is the term used to describe the group of species that will pollinate a plant. Pollinator guilds can be composed of a particular group of organisms, such as bees, or can be a mix of several groups, such as flies and beetles. Our knowledge of the composition of these pollinator guilds is limited, especially in the case of prairie plants. Even less information is available about how these guilds have changed over time. Changes in pollinator guilds can sometimes have a negative impact on the reproductive success of a species.

From 1998 to 2000 I studied the reproductive biology of the pale spiked lobelia (*Lobelia spicata*) at the Midewin National Tallgrass Prairie (Midewin). The pale spiked lobelia is a short-lived prairie perennial that blooms in northern Illinois from May to August. It is a gynodioecious species, which means that there are both hermaphroditic and female individuals. To understand the reproductive biology of this species it was necessary to identify its pollinator guild. Through personal observations, I determined that the main pollinators of pale spiked lobelia are bees.

During the course of this study I found a Ph.D. thesis by J.F.W. Pearson entitled "Studies on the Ecological Relationship of Bees in the Chicago Region." During 1930–31 Pearson visited and collected bees in several towns in the Chicago region (Ashburn, Chicago, Lemont, Matteson, New Lenox, Palos, Somonauk, South Chicago, Volo, Waukegan, Willow Spring, and Zion). He listed all the plant species associated with the bees, including the pale spiked lobelia. Because Midewin is just 10 miles from one of the towns that Pearson sampled, I decided to determine how the pollinator guild (i.e., bees) had changed over the past 70 years.

In 1999 I collected bees at Midewin and Dr. Wallace LaBerge (Illinois Natural History Survey) identified these specimens. I found that pale spiked lobelia at Midewin is pollinated by four bee species, *Augochlorella striata* being the main pollinator (see Table 1 and Fig. 1). Pearson had also found four bee species associated with pale spiked lobelia in the Chicago region (see Table 1). Only one common species, *Ceratina dupla* (Fig. 1), was found at Midewin and in the Chicago region. Pearson did not provide information about the main pollinator.

Figure 1. Two of the four bee pollinators of spiked lobelia found at Midewin—*Ceratina dupla* (left) and *Augochlorella striata*.

Photos by David Voegtlin, INHS Center for Biodiversity

It can be argued that although bees are still the main pollinators of pale spiked lobelia, the pollinator guild has changed over the past 70 years. Only one species is still the same between Midewin and the Chicago region of the 1930s. However, it is possible that at Midewin I may have underestimated the pollinator guild of pale spiked lobelia. At Midewin the few species of bees that were found may reflect the habitat where the study was conducted—a degraded prairie that was heavily grazed in the past. Few prairie species can be found at the study site, and fewer are blooming when pale spiked lobelia is blooming. This may decrease the attractability of the site for pollinators, affecting the size of the pollinator guild. It is likely that if a native prairie is visited, the pollinator guild of this species will increase. However, it is interesting to note that Pearson also detected only four species in the Chicago region. This suggests that the pollinator guild of pale spiked lobelia is small.

Finally, in another part of this study I found that both female and hermaphroditic individuals had a high reproductive output. This suggests that although the pollinator guild of pale spiked lobelia has changed over the last 70 years, this change does not appear to have had a negative impact on the reproductive output of the species.

Brenda Molano-Flores, Critical Trends Assessment Project and Center for Biodiversity

Table 1: Bees associated with pale spiked lobelia at the Midewin National Tallgrass Prairie and in the Chicago region (Pearson 1932).

Midewin National Tallgrass Prairie		Chicago Region	
Family	**Genus/species**	**Family**[1]	**Genus/species**
Andrenidae	*Andrena wilkella* (Kirby)	Megachilidae	*Alcidamea simplex*[c]
Halictidae	*Augochlorella striata* (Provancher)	Ceratinidae[a]	*Ceratina dupla* Say
Anthophoridae	*Ceratina dupla dupla* Say	Megachilidae	*Megachile brevis* Say
Apidae	*Tetralonia hamata* Bradley	Eucerdae[b]	*Tetralonia dilecta* (Cresson)

[1]Current nomenclature: a) Anthophoridae, b) Apidae, c) *Hoplitis simplex* Cresson 1864 (Heriades).

Largemouth Bass Recruitment and Stocking Strategies

Although largemouth bass are frequently stocked in many Illinois impoundments to compensate for variable recruitment, the long-term contribution of stocked fish to recruitment and harvest of natural bass populations is unknown. Because stocking is only one of several management options for this species, it is critical that additional information on factors limiting recruitment processes be identified. The ultimate goal is to develop management strategies that maximize growth, recruitment, angling opportunities, and harvest of largemouth bass in Illinois impoundments. Our ongoing research in cooperation with the Division of Fisheries, Illinois Department of Natural Resources should enable us to achieve these goals.

Largemouth bass recruitment depends on a variety of biotic and abiotic factors such as prey availability, predator abundance, population structure, vegetation, water level, temperature, spawning habitat, and angling. Our objective is to determine important mechanisms affecting largemouth bass recruitment in Illinois impoundments to help improve bass fisheries and optimize management efforts. Thus far we have sampled 10 lakes to assess the influence of these factors on largemouth bass recruitment. The lakes chosen for this study varied in surface area, latitude, and productivity. In addition, we chose lakes with poor, medium, and good largemouth bass recruitment.

Densities of young-of-year (YOY) largemouth bass are different across lakes and years, suggesting recruitment is lake dependent as well as dependent on large-scale environmental events. Environmental events such as below-normal temperatures or below-average rainfall will also likely influence recruitment across years. The importance of these variables can be assessed only through multiyear evaluations. Our preliminary results suggest it is likely that the number of successful spawners, predation, and available prey have a large influence on growth and survival of juvenile largemouth bass. We found that peak YOY largemouth bass abundance occurred in lakes with high juvenile bluegill densities. It is unclear whether the abundance of juvenile bluegill directly affects bass recruitment or whether similar factors are affecting both species. Growth of largemouth bass also differs across lakes and becomes more pronounced through fall. Additional study years will help us to identify factors controlling largemouth bass growth and survival and will increase our ability to effectively manage largemouth bass populations.

Blake Davis electrofishing for largemouth bass on Lake Bloomington. **Photo by Karen Schnake, INHS Center for Aquatic Ecology**

Removal of spawning males by angling in the spring may or may not affect largemouth bass recruitment. Another objective is to assess the level of angling for nesting bass in Illinois and to determine its impact on reproductive success and annual recruitment. We are currently monitoring the amount of angling for nesting bass through bass tournaments and creel surveys. To examine the relationship between reproductive success and recruitment in largemouth bass, we are monitoring nesting success in Lincoln Trail Lake and ponds at the Sam Parr Biological Station. By draining these ponds in the fall, we will be able to assess the number of juveniles produced and determine the relationship between reproductive success and fall recruitment. This information will help us identify the critical period of recruitment for YOY largemouth bass.

Stocking of largemouth bass is often used to compensate for poor recruitment in an already existing bass population. Surprisingly, few studies have looked at the effectiveness of different largemouth bass stocking strategies. We are evaluating the success of four size groups (2", 4", 6", and 8") of stocked largemouth bass in several lakes across Illinois. Preliminary results from Lake Charleston in Coles County, Woods Lake in Moultrie County, Homer Lake in Champaign County, and Lake Mingo in Vermilion County indicate that larger fingerlings (6" and 8") have higher survival rates than small and medium fingerlings. Mortality related to stocking stress was not evident in any size class of stocked bass. Size of largemouth bass collected in the fall and spring was related to the initial size at stocking. Cost-benefit analyses will be conducted to determine the most appropriate stocking options for use in Illinois under various conditions. We also are evaluating rearing techniques by stocking both hatchery-reared and pond-reared largemouth bass fingerlings in Lake Shelbyville in Moultrie and Shelby counties, Lake Jacksonville in Morgan County, and Walton Lake in Montgomery County. Fingerlings from rearing ponds contributed more than those from hatchery raceways in all three lakes. Higher survival of the rearing pond bass may be the result of these bass being stocked at a larger size.

We are also evaluating the long-term contribution of stocked largemouth bass to the numbers of harvestable and reproducing adults. Largemouth bass are being stocked into selected study lakes with a genetic tag (fixed for the MDH-B2B2 genotype). Background allele frequencies were collected on each study lake before largemouth bass were stocked. Following introductions, the relative increase in the frequency of individuals in that year class with that rare MDH-B2B2 genotype will be used to determine the relative success of the stocking. Once those year classes reach maturation, the contribution of the stocked individuals relative to resident, native individuals in number of young produced will be determined for several successive year classes. In addition, information on the importance of rearing technique, size of stocked fish, forage base, cover, resident predators, physical-chemical conditions, and stocking stress in determining largemouth bass stocking success will allow optimal use of hatchery- produced fish.

John H. Hoxmeier, Joe J. Parkos, Ken G. Ostrand, David P. Philipp, and David H. Wahl, Center for Aquatic Ecology

Species Spotlight

Poison Ivy

Susan Post

If, as a child, you are going to explore the outdoors, a series of three familiar rhymes must be learned very early—Leaves three, leave it be; Leaflets three, let it be; or Leaves three quickly flee. These rhymes may help you avoid poison ivy, and thus a painful lesson. These folk rhymes probably arose soon after the colonists' first encounter with the plant. Poison ivy

Poison ivy, an all-too-common plant found throughout Illinois. **Photo by Charlie Warwick, INHS Office of the Chief**

is neither poison nor an ivy; instead, it is related to the sumac and belongs to the cashew family—Anacardiaceae. Its scientific name *Toxicodendron radicans* is intended to spell out the nature of the weed. *Toxicodendron* is a combination of Greek words meaning poisonous tree or plant, while *radicans* is Latin for rooting, referring to the roots the stems send out. Its other common names include poison vine, poison creeper, three-leaved ivy, picry, and mercury.

Poison ivy is found in every county in Illinois. With the exception of Alaska, Hawaii, Nevada, and California, it is also found throughout the United States below 5,000 feet in elevation. It follows civilization, cropping up in disturbed sites like cut banks, roadsides, and old fencerows. It prefers woodland borders and clearings, shunning dense forest.

Poison ivy is a long-lived, vigorous, ropelike, hairy vine that can also grow as a creeper or a medium shrub. The vines can grow 75 feet long and 6 or 7 inches thick. The hairs on the vines are aerial roots that look like reddish brown fuzz on new growth, but darken with age. An old vine can look like a fuzzy rope. These hairs have an adhesive that binds the vine to whatever it climbs on. The vine doesn't spiral but grows straight up, favoring the grooves in rough bark. It has an extensive root system that grows just below ground level.

The plant is actually not three-leaved. Its leaves are compound, consisting of three leaflets to each leaf. Each leaf is attached to the stem of the plant with a long petiole (leaf stem). The leaves grow up the stems alternately, rather than paired. Whitish flowers appear during May and June. The flowers are on slender stems that grow from the angles between the leaves and woody twigs. These flowers yield tiny, berrylike drupes (stone fruit like cherries or peaches). In the winter the plant becomes leafless and dormant.

Found in the tiny subsurface duct glands of poison ivy are resinous oils called urushiol. These oils are found in the plant's stems, roots, leaves, flowers, and fruit year round, and can cause a reaction even when the plants are dormant or a long time after the plant is dead. Urushiol is insoluble in water, resists drying, and stores very well. To get a rash (an allergy attack) you must touch the oil, which usually requires bruising the plant. Many humans (75–80%) are potentially allergic to these oils. The only sure remedy is to recognize and avoid the plants.

For those who are allergic to the plant, its benefits are often overlooked. Poison ivy is an early colonizer, often taking hold in the scars we leave and beginning the slow process of rebuilding the landscape. The plant requires very little nourishment or moisture (less than 10 inches yearly). It is virtually pest free, the roots provide erosion control, and it attracts and sustains wildlife. Though no poison ivy occurs in England, it was imported for its fall color. It was subsequently introduced into Australia and New Zealand where the plants act as a garden backdrop. Perhaps they also help keep the local dermatologist in business.

A note for teachers:
There are a few terms that may need to be explained to the students.

- A **herbaceous** plant is one that is not woody.
- Each **leaf** of a plant will have a bud at its base where it joins to the stem. If the leaf is made up of one section or blade, it is called a **simple leaf**. If there is more than one section, each of which looks like a leaf but does not have the bud at the base, then it is a compound leaf. Each section of the **compound leaf** is called a **leaflet**.
- If the edge of the leaf has pointed projections, it is said to be **toothed**. If the edge of the leaf has rounded projections, it is said to be **scalloped**.
- A **seedling** is a young plant that has recently emerged from a seed.

Answers to Poison Ivy Look-alikes: 1-d, 2-e, 3-g, 4-c, 5-j, 6-a, 7-h, 8-f, 9-i, 10-b

Drawing credits

Poison ivy—Carie Nixon
Wood sorrel—Dover*
Jack-in-the-pulpit—Dover*
Fragrant sumac—*Fieldbook of Native Illinois Shrubs*, Illinois Natural History Survey Manual 3, Leo R. Tehon.
Box elder—Dover*
Wild strawberry—Dover*
Trillium—Dover*
White clover—Dover*
Columbine—Dover*
Black raspberry—*Fieldbook of Native Illinois Shrubs*, INHS Manual 3, Leo R. Tehon
Rough cinquefoil—*Weeds of the North Central States*, North Central Regional Research Publication No. 281, Bulletin 772. University of Illinois at Urbana-Champaign, College of Agriculture, Agriculture Experiment Station.

* Dover = *Plants and Flowers: 1,761 Illustrations for Artists and Designers*. Edited by Alan E. Bessette and William K. Chapman.

Poison Ivy Look-alikes

Carolyn Nixon

Poison Ivy Look-alikes

Now that you know the story of poison ivy, you know that you should avoid touching the plant with three leaflets; however, there are several other plants that also have three leaflets, and some with simple leaves that come in sets of three. Some are easily confused with poison ivy, while others look quite different. Here are just a few. Match the pictures on the right with the names and descriptions on the left.

1. Trilium is a woodland wildflower and a member of the lily family. It has three glossy, untoothed leaves. The flowers have three petals, and come in white or reddish purple. The white flowers turn pink with age. _____

2. Jack-in-the-pulpit has one or two smooth-edged leaves, each with three leaflets. The flower is a greenish tube with a hood, and has an erect club under the hood. _____

3. Fragrant sumac is a close relative of poison ivy. It has three fuzzy leaflets, with the center leaflet having a short stalk. It has clusters of small, round, fuzzy, red fruit. It grows as a low, spreading shrub about three feet tall. _____

4. Box elder is a type of maple tree that lives in moist woodlands. The leaves have three to seven toothed leaflets, and the seedling box elders usually have only three leaflets. _____

5. Wild strawberry is a low-growing herbaceous member of the rose family. The leaves have three hairy and toothed leaflets. The flowers are white, followed by red fruit. _____

6. Wood sorrel is a common weed in lawns and gardens. Its leaves are three heart-shaped leaflets about 1/2 inch across. It has small yellow flowers each with five petals. _____

7. White clover is a small herbaceous plant that is common in lawns. It has leaves with three finely toothed leaflets and a cluster of tiny white flowers that form a ball about 3/4 inch across. _____

8. Columbine is an upright wildflower with nodding red and yellow flowers. Its light green leaves each have three deeply scalloped leaflets. _____

9. Black raspberry is a shrub with long unbranched stems, or canes, that have many hooked thorns. The younger canes are often covered with a whitesh film. The leaves have three toothed leaflets that are whitish underneath. _____

10. Rough cinquefoil is a spreading or erect herbaceous member of the rose family. Its deeply toothed leaflets tend to fold upward at the edges. It has inconspicuous yellow flowers. _____

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Exploring the Nature of Illinois

A Joint Project of the Illinois Natural History Survey, the University of Illinois Department of Natural Resources and Environmental Sciences, the Cache River State Natural Area (IDNR), and the Cypress Creek National Wildlife Refuge

Illinois Natural History Survey Reports is published bimonthly by the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820 Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the Illinois Department of Natural Resources.

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The Reptiles and Amphibians of Illinois

Join survey herpetologist Dr. Chris Phillips and his students for a unique three-day workshop on Illinois' most fascinating, yet often misunderstood, inhabitants—its snakes, lizards, frogs, toads, and salamanders.

Where: Shawnee Community College near Ullin in Pulaski County. The class will include visits to Pine Hills Ecological Area, various sites in and near the Cache River State Natural Area, and the Shawnee National Forest.

When: September 21–23.

Course Description: The course will be a mix of classroom and field experiences. Participants will learn how to identify Illinois reptiles and amphibians, study their life cycles, examine various behaviors, and explore the status of these unique creatures.

Participants will receive a signed copy of *Field Guide to Amphibians and Reptiles of Illinois,* numerous handouts, and other materials. Lunch and dinner will be provided on Saturday, September 22, and lunch will be furnished on September 23.

Participants should come prepared to spend considerable time in the field as well as in the classroom. The maximum walking distance during field trips will be 1 to 2 miles. Evening classes are scheduled for both September 21 and 22.

Cost: Tuition for the course is $125 and includes all course materials, meals, and snacks. Breakfasts are on your own, as are lodging costs at nearby motels. Room arrangements are the registrant's responsibility and will not be made by the Illinois Wilds staff.

To register for the above class or to ask questions about the course, call Susan L. Post at (217) 493-9959 or leave a message at (217) 333-6659. You may also register by e-mail at the following address: spost@mail.inhs.uiuc. edu.

.OIS NATURAL HISTORY SURVEY

Reports

Autumn 2001
No. 369

INSIDE

Bio Blitz Collects 2000+ Species in 24 Hours

During June 29–30, the Survey undertook a unique exercise—a 24-hour, all-taxa survey of a designated site in central Illinois—the Biodiversity Blitz. The Survey has been in the biological inventory business for over 140 years, amassing enormous collections and data centered around Illinois biodiversity, but this event presented several challenges. Exactly what does it take to do an all-species inventory in a defined time slot? The answer is not so simple.

First, a suitable site is needed, in this case, the University of Illinois' Robert Allerton Park near Monticello, IL. Allerton was chosen because it has a diversity of habitats, is virtually an island surrounded by agricultural lands, and was large enough to be challenging yet small enough to be doable.

Second, it takes a cadre of scientists with a great variety of knowledge and skills—everything from protozoology to mammalogy. For the Blitz, over 160 scientists participated. The entomologists had the most scientists, 47, but other groups were well represented. The list included 16 botanists, 8 ornithologists, 7 mammologists, 5 herpetologists, and even a lone sponge specialist! Scientists were divided into two groups. Level One scientists were leaders of groups and were responsible for the identification of the organisms they found. Level Two scientists served as collectors, curators, and other types of field assistants.

Third, it takes dedication and organization. The Illinois Natural History Survey, with help from the Illinois Department of Natural Resources and the University

Continued on back page

Effects of Exotic Plants on Bird Nesting Success

Invasive species have been implicated as a major or contributing cause of declines for nearly half the endangered and threatened native species in the U.S. In Illinois, the number of exotic or invasive plants is unknown, but several (garlic mustard, kudzu, autumn olive) seriously threaten Illinois habitats.

Wetlands in Illinois, already reduced by 85%, are invaded due to disturbance from development, altered hydrology, or runoff. Purple loosestrife (*Lythrum salicaria*), a Eurasian plant that invaded North American wetlands in the 1800s, now dominates many Illinois wetlands. Due to the ineffective management of loosestrife through other methods (e.g., herbicides, burning, flooding), purple loosestrife has been the target of biological control agents (natural enemies such as insects and pathogens) imported from Europe.

Researchers dwarfed by purple loosestrife plants. **Photo by J. Dylan Maddox, UIUC**

Illinois has one of the nation's most active biological control projects against purple loosestrife, with nearly 2 million agents released and apparent success seen at several sites. However, the national loosestrife biological control program has been criticized as unnecessary. Critics claim purple loosestrife poses little threat to native species, especially birds, because nesting females have been observed in loosestrife-infested wetlands.

Data regarding the effects of invasive plants on birds are limited. Numerous factors could result in lower (or even higher) reproductive success, but we believe two stand out: limited prey abundance and elevated predation rates. Exotic, invasive plants thrive in new areas not because they are intrinsically superior to their native counterparts, but because their natural enemies are absent. Natural enemies, usually insects, control plants in their native distributions, but most are never introduced with their host plant. Thus, large stands of purple loosestrife may contain fewer insect prey, which could result in increased starvation by nestlings relying on insect prey as food. This notion is supported by the finding that about 120 species of insects are found feeding on purple loosestrife in Europe, whereas only 12 were found in a study in southern Manitoba.

Nest failure is largely the result of nest predation, and predation rates are greatly influenced by vegetation characteristics of nest sites. The encroachment of an invasive species will, to some extent, modify vegetation characteristics and perhaps render nests more susceptible to predators. For example, a 1999 study by Schmidt and Whelan showed that birds nesting in exotic plants experienced higher predation rates and lower reproductive success than nests built in comparable native shrubs. These elevated predation rates were attributed to structural differences of exotic plants. Structure of purple loosestrife differs drastically from native wetland plants.

In cooperation with the Chicago Department of Environment, Illinois Natural History Survey scientists initiated a two-year study in the Lake Calumet region of northeastern Illinois to examine the effects of purple loosestrife on wetland birds. Preliminary data of approximately 90 nests found during the 2000 breeding season suggest

1. Red-winged Blackbirds nesting in purple loosestrife were less likely to succeed (31% nest success) than birds nesting in cattail (37% nest success);
2. Redwings avoid nesting in purple loosestrife until early to mid-June, whereas nests in cattail were initiated in early May;
3. Starvation was equally common in loosestrife and cattail habitats;
4. Marsh Wrens were never found nesting in loosestrife, only cattail.

Red-winged Blackbird nest with eggs. **Photo by J. Dylan Maddox, UIUC**

Also, in 2001, one of the wetland sites was burned. Although large stands of loosestrife did not burn, all cattails burned, leaving no plant structure for nesting. At that particular site, neither Red-winged Blackbirds nor Common Grackles nested in loosestrife until after June and Marsh Wrens were entirely absent. This anecdote seemingly further supports our assumption that loosestrife is not suitable habitat for nesting birds at least until later in the breeding season.

It appears that elevated predation rates in loosestrife are not related to predation patterns commonly reported in other nest predation studies, e.g., edge, plot, or seasonal effects. Our results may indicate findings similar to those of Schmidt and Whelan in that vegetation structure might facilitate the movement of predators in purple loosestrife. We hope current data collection will provide more insight to these findings.

J. Dylan Maddox, NRES-UIUC, and Robert N. Wiedenmann, Center for Economic Entomology

Land-cover Classification for Forests

A land-cover map depicting major vegetational communities is one example of how satellite imagery is used in natural resource mapping. For many projects at the Illinois Natural History Survey (INHS), the creation of maps and databases that allow analyses of landscapes begins on a computer screen. While many scientists at INHS conduct research on ecology or some other area of biology, others classify satellite imagery, a difficult task.

Satellites actually measure the reflectance of visible light and other electromagnetic radiation off the land. As a satellite looks down upon the earth, it records data in pixels. Each pixel is about the size of a baseball diamond (30-m square) and must be classified based upon its reflectance of different wavelengths of light and other radiation. All these data are recorded and classified into similar categories. Additional processing is needed to determine what the various classifications mean in terms of ground vegetation.

The task of classifying the land cover of the state—a daunting task—is being shared. Don Luman and others at the Illinois State Geological Survey have classified the agricultural portion of the state (about 75% of the land area) as part of an agreement with the National Agricultural Statistical Service. INHS researchers are in the process of classifying the forests, wetlands, and grasslands of Illinois. The project is about half complete in generating a full land-cover map of Illinois based upon imagery acquired in 2000. Eventually this land-cover map will be used to model wildlife habitats and to evaluate land-cover conditions. The land-cover map will be used to examine land-use practices in Illinois, with hopes of assisting state agencies as they plan conservation measures including acquisitions, stewardship programs, and incentive programs.

The forests of Illinois are a particular challenge in classification. Because many wildlife species make their homes in forests, we have found that detailed mapping of the forests is very desirable. One of the difficulties in mapping the forests is identifying the dominant plant community in any given area. Because each pixel represents an area of 30 meters by 30 meters, some pixels may include more than one plant community. To improve interpretation of land-cover type from the imagery, we use "spatial patterning," that is, we look for patterns in the landscape that indicate dominance of a specific tree species in that area.

For example, we are currently examining the area around the Wabash River from the southern part of Edgar County to the northern part of White County to the western edge of Effingham County. A computer program statistically places pixels into different classes based on the reflectance characteristics, grouping similar pixels together. Next, we examine the classes created by the computer program and assign each a name. For example, many forests around rivers have different spectral and spatial patterns than forests in upland areas (see photo). Researchers may also use an elevation model to determine the trees in upland versus bottomland locations. Soil surveys and aerial photographs are also very helpful in defining tree species based on location and soil type, but the work may not end there. We also rely on experts to tell us whether our analysis is reasonable. With the challenges of this work, a land-cover map specialist at INHS becomes part scientist, detective, computer jockey, and naturalist. Who says computer work is boring?

Land-cover map of an area in the south-east part of Crawford County. The Wabash River represents the border between Illinois and Indiana. The white "pixelized" areas along the Wabash represent a community of wet/wet-mesic floodplain forest. This may contain trees such as silver maple, beech, or tuliptree.

Brooke Bahnsen and Patrick Brown, Center for Wildlife Ecology

Biotic Inventory of Kyrgyz Grasslands

Temperate grasslands are the most threatened of the world's ecosystems. In Illinois less than 0.1% percent of our original native prairie vegetation remains and most of the loss has occurred within the last 150 years. Native grasslands harbor an enormous diversity of species, including the most important food plants of humans and domestic animals. Consequently, they also harbor the herbivorous insects that consume these plants, some of which are now considered agricultural pests, as well as the natural enemies of these pests. Thus, study of native grassland biotas is desirable not only because they are rapidly disappearing worldwide, but also because of the economic importance of grassland organisms.

Despite the importance of grasslands to human civilization, basic knowledge of the grassland biota is still very incomplete. New species, particularly of diverse groups such as insects, continue to be discovered, and the interactions among grassland plants and animals, such as the relationship between plants and their insect pollinators, remain poorly understood. The relationships among the floras and faunas of different grassland regions are also incompletely known. Such knowledge is crucial to an improved understanding of the factors that create and maintain native grasslands as functioning ecosystems. Globalization of the economy and the increasing impacts of non-native species provide additional impetus for the study of grassland biotas. Many North American grasslands are dominated by plant and animal species introduced from Eurasian grasslands, and accidental introductions of exotic species are becoming more frequent.

INHS research assistant Dmitry Novikov (lower right) vacuums insects in a mountain meadow in the Trans-Alaj Range of southern Kyrgyzstan. **Photo by Christopher Dietrich, INHS Center for Biodiversity**

Although intensive study of the remaining Illinois prairies continues to be a top priority at the Illinois Natural History Survey, studies of grasslands in other parts of the world are also necessary to provide baseline data on poorly sampled regions and to help place the Illinois biota in a global perspective. Central Asia has some of the world's most extensive remaining temperate grasslands, most of which are encompassed within the borders of the former Soviet Union. The breakup of the Soviet Union has facilitated closer collaboration between U.S. and former Soviet scientists and provided opportunities for fieldwork in regions formerly off limits to U.S. researchers. Entomologists and botanists from INHS took advantage of this to conduct an inventory of the grassland vascular plants and arthropods of a former Soviet Republic, Kyrgyzstan, during the 1998–2000 field seasons.

Kyrgyzstan is a country about the size and latitude of South Dakota, situated to the northwest of China and bordering the other former Soviet central Asian republics of Tajikistan, Uzbekistan, and Kazakhstan. The main physiographic features of Kyrgyzstan are the Tien Shan, a mountain range consisting of a series of east-west trending ridges including numerous peaks over 5000 m tall, and Issyk-Kul, a large freshwater lake in the northeastern part of the country. Kyrgyzstan is an attractive place to study grasslands because it has a wide variety of grassland types arranged along relatively steep elevational and moisture gradients. Forests in Kyrgyzstan are almost entirely restricted to riverbanks and to the ridges surrounding Lake Issyk-Kul.

The goals of our project were: (1) to document the vascular flora and arthropod fauna of Kyrgyz grasslands, (2) to collect specimens of as many species as possible for use in basic systematic research, (3) to obtain quantitative data on arthropod and plant species richness and vegetative cover, (4) to document ecological interactions among arthropods and plants; and (5) to create a specimen-level relational database for the specimens collected.

Our sampling plan involved visiting as many sites as possible that represented a variety of grassland types and elevational classes during three month-long expeditions conducted over three years (1998–2000). Some sites were sampled repeatedly over the three years and some were visited only once. At 42 sites, we established 100-m transects for quantitative sampling of both plants and insects. Within these transects we sampled plants in 20 3/4-m^2 quadrats, recording species occurrence and percent cover. We sampled insects along these same transects using a sweep net and by vacuuming. We also made many additional collections of plants and insects by walking each site in an attempt to document the flora and fauna as thoroughly as possible.

Over the three years of the project, we sampled 119 sites and collected 579 insect samples containing approximately 100,000 individual insect specimens. We also collected about 2,300 plant specimens. The processing of these samples and identification of species have been the most time-consuming part of this work. We are currently distributing plant and insect specimens to specialists for identification and constructing a relational database that will include a record for each specimen collected linked to information on the locality. Eventually, we plan to incorporate our data and specimens into a variety of analyses. These analyses will include the estimation of species richness, diversity, and complimentarity; cladistic biogeographic study of Holarctic grasslands; study of community structure and its determinants using ordination; and basic systematic research including phylogenetic analysis and the description of new genera and species.

Chris Dietrich, Center for Biodiversity

The Endangered Hine's Emerald Dragonfly

The Hine's emerald dragonfly is the only federally endangered dragonfly species in the United States. The species occupies wetland marshes and sedge meadows fed by shallow groundwater. Like many endangered species, the major reason for its endangered status is habitat loss. Wetland loss is widespread in the United States and in Illinois over 90% of wetland acreage has been lost. Populations of Hine's emerald dragonflies survive in some of the remaining wetlands in Illinois, Wisconsin, Missouri, and Michigan, while the historical range is believed to cover a much larger and more continuous area. The majority of what is known about the Hine's emerald dragonfly's habitat requirements, behavior, and ecology has followed its listing as an endangered species in 1995. Larval habitat use has been studied intensively; however, adult habitat use has proven to be more challenging. The adults are fast fliers and difficult to capture. Studies have shown a male bias in the adult sex ratio and there is limited information on female activity patterns and distribution. Our current research has provided a better understanding of female distribution that contributes to our knowledge of habitat use.

Larval monitoring in Illinois and Wisconsin has shown that the larvae spend two to four years in the aquatic habitat, avoiding predation from crayfish and periods of drought. The lucky survivors crawl out of the water onto emergent vegetation and break out of their larval skins, or exuvia. Exuvia are left behind by the emerging dragonfly and the careful observer can find these skins and determine useful information about the ecology of the species at this stage. Our recent research has suggested an equal number of males and females at emergence despite high male biases in the adult stage.

The adult stage can last several days to several weeks. During the adult stage, males patrol temporary territories in the wetland habitat and females must come into the habitat to lay their eggs. Adults feed on small aerial insect prey in the wetland, in dry meadows, along lakeshores, and in forest clearings. Previous adult studies by researchers at both the Illinois Natural History Survey and the Illinois State Museum have reported a high male bias in the sex ratio. These surveys have, however, been concentrated in the wetland habitat. As a result, it is unknown whether this sex ratio is a reflection of differences in male and female habitat use or higher female mortality rates. Differences in habitat use may result in female avoidance of areas with high male densities and possibly male harassment. Higher female mortality may result from the extra costs associated with producing and carrying eggs. The question is, Where are the female dragonflies? This is a common question in dragonfly biology as well as being an important question when considering conservation of this species.

Hine's emerald dragonfly with bee tag.
Photo by Sophie Foster, INHS Center for Aquatic Ecology

Knowledge of the adult sex ratio and female habitat use is important for two reasons. First, if males are more abundant than females, the genetic variability will be compromised in later generations. Ultimately, the lack of gene variability will threaten local populations during outbreaks of disease, severe weather, or other environmental stresses. Second, if females are using different habitats than males, then it is critical that both habitats be protected to ensure survival of the Hine's emerald dragonfly.

Last summer adult populations were monitored in wetland and dry meadow habitats to determine if there is a difference in habitat use between males and females. Dragonflies were caught in insect nets and individually marked with bee tags. We determined that the overall adult sex ratio was equal, and differences in male and female habitat use were confirmed. Males were more abundant in the wetland habitats and females were more abundant in the dry habitats. These differences in habitat use may result from male harassment or differences in food availability. Although we observed mating pairs in both habitat types, no male harassment was observed in the dry meadow habitat. Low levels of male harassment limited our ability to make strong arguments for or against this explanation. Insect prey (flies and in particular midges) collected on sticky insect traps were more abundant in the wetland habitats, suggesting that when females avoid these habitats it is not because they have less food. Other untested differences in the habitats may be influencing female distribution patterns.

Whatever the reason for the observed patterns of male and female distribution, sampling in alternative habitats has provided us with a greater understanding of Hine's emerald dragonfly habitat use than exists for most dragonfly species. Populations of males and females occupy a larger area of habitat than wetlands, and both wet and dry habitats are necessary for the survival of this species. This work demonstrates how habitat use by both sexes is an important consideration for species conservation.

Sophie E. Foster and Daniel A. Soluk, Center for Aquatic Ecology

Species Spotlight

Fireflies

Susan Post

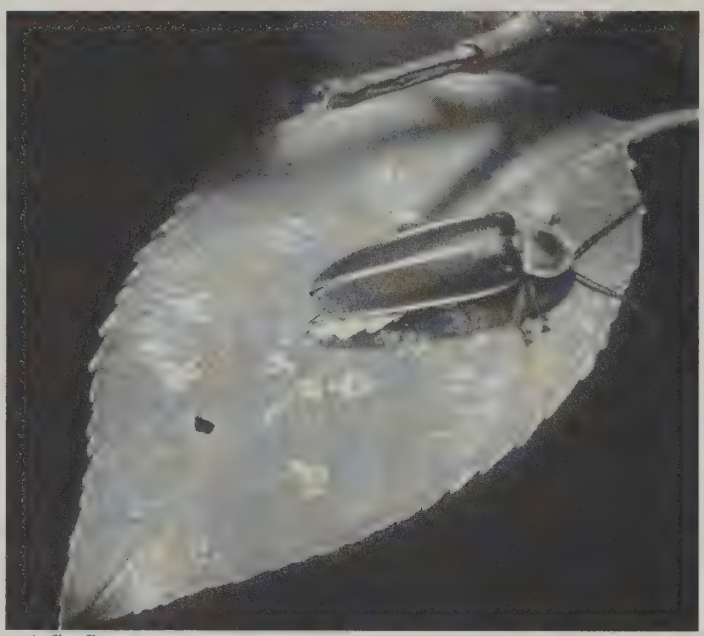
Here come the real stars to
fill the upper skies,
And here on earth come
emulating flies
That, though they never
equal stars in size
(And they were never really
stars at heart),
Achieve at times a very
starlike start.
Only, of course, they can't
sustain the part.

Robert Frost,
"Fireflies in the Garden"

Fireflies herald both the beginning and end of meteorological summer. We notice their flashing in early June when the nights are long, and by the time the cicadas and katydids loudly serenade us, the fireflies have disappeared and it is fall.

Fireflies are not flies, nor are they bugs as their other common name (lightning bug) denotes. They are beetles, members of the insect family Lampyridae, which means "shining fire." A firefly is an elongate, soft-bodied insect whose pronotum (the upper surface of the first thoracic segment) extends over its head, concealing it when viewed from above. A firefly is usually brown or black with red or yellow markings on its large, shieldlike pronotum. In North America there are 20 genera and at least 136 species of fireflies.

While other luminescent insects glow continuously, fireflies flash their lights on and off. The segments near the end of the firefly abdomen are able to produce light. These luminous segments can be recognized, even when the insect is not glowing, by their yellowish-green color.



A firefly. **Photo by Michael Jeffords, INHS Center for Economic Entomology**

Fireflies produce cold light. A cold light is one that produces no heat as a by-product. In the fireflies nearly 100% of the energy given off appears as light, whereas with an electric light bulb only 10% of the energy is light and the other 90% is given off as heat. Fireflies generate their light by combining a chemical, luciferin, with an enzyme, luciferase, and oxygen. Luciferin is stored in the cells of the light organs, which are richly supplied with air tubes. Fireflies control light production by regulating the oxygen supply to the light organs. The light produced is merely a by-product of this chemical reaction—a brief release of energy. The "fire" is actually cool, containing virtually none of the infrared wavelengths possible within the spectrum of light. It is also nearly all-visible, containing almost no ultraviolet components. This light is attractive to other fireflies, as well as us, and it makes them one of a few groups of insects to use sight instead of smell to find mates.

Midwestern fireflies are solitary, each searching independently for a mate. Both sexes flash, but the male's is brighter and more frequent and each firefly species has its own unique male signal and female response. From dusk until the fall of total darkness the males will fly, crisscrossing an area, flashing rhythmically while the female remains stationary on the ground or in a bush and responds to the male with her own flashes. When the male receives an answer, he hovers and orients his lantern toward the female. Eventually he lands near her and they mate.

Each species of firefly has its own pattern of flashing light. These patterns may be as plain as a series of dashes or dots or more elaborate, such as a swooping "J." There are differences in the duration of the flash, time between flashes, color of flashes, the number, rate, and intensity of the flashes, and how far the firefly travels between flashes. Some species are active just before sunset, others just after. Temperature also affects fireflies—as it gets warmer they flash more often and the flash appears brighter.

Fireflies overwinter as larvae buried in the soil. The larvae are predaceous and have elongated, sickle-shaped jaws that are used to inject a toxin into their prey. This toxin also aids in liquefying the prey's body contents so the firefly larvae can suck their victims dry. The larvae feed chiefly on land snails, earthworms, caterpillars, and other soft-bodied invertebrates. They are nocturnal and are found on the ground in moist areas, usually under bark or stones or in decaying vegetation. Some of the larvae are luminescent. The larva surrounds itself with mud and pupates; and the adults will emerge 10 days later.

While just seeing fireflies flash during the summer gives pleasure, fireflies also provide practical benefits to humans. Their luciferase is an enzyme that can help in screening for human tumors, in testing for blood problems, and as a fast-acting detector of an infection. It has been on the market in a genetically engineered form for over 10 years.

Susan Post, Center for Economic Entomology

The Naturalist's Apprentice

Communicate With Light

Carolyn Nixon

Both male and female fireflies flash lights to attract mates. These "cold" lights are produced by a chemical reaction within the abdomen of the firefly. The males fly close to the ground and emit flashes of light while performing acrobatics. Each species has its own characteristic pattern. For mating to take place, the female firefly (of the same species as the flashing male) must respond with pulses of light at exactly the correct time interval after the male's flashes before he will fly over to her to investigate.

You can learn to communicate with flashing lights similar to the way fireflies do. All you need is a flashlight (one with a button that you push to turn it on and that will turn off when you release it works best) and a knowledge of International Morse Code (shown below). Practice the letters shown below by shining the flashlight on a wall in front of you so you can easily see a spot of light. For a dot, press and release the button on the flashlight quickly. For a dash, hold the button down longer, usually three times longer than you do for the dot. Pause between letters (a pause about the length of time as a dash works well), and pause at least three times longer between words. Try learning a few simple words first, your name, and then a short sentence.

Practice with a friend. Once you both learn Morse Code, you can communicate with each other with a flashlight. Do not try to remember the letters as they are sent to you; instead, use a piece of paper and a pencil to write down the letters as you receive them. That way you can concentrate on one letter at a time and not worry that you will forget those letters that were already sent to you.

International Morse Code

Letter	Code	Letter	Code	Digit	Code	Punctuation Mark	Code
A	· -	N	- ·	0	- - - -	Period	· - · - · -
B	- · · ·	O	- - -	1	· - - - -	Comma	- - · · - -
C	- · - ·	P	· - - ·	2	· · - - -	Question mark	· · - - · ·
D	- · ·	Q	- - · -	3	· · · - -	Apostrophe	· - - - - ·
E	·	R	· - ·	4	· · · · -	Hyphen	- · · · · -
F	· · - ·	S	· · ·	5	· · · · ·		
G	- - ·	T	-	6	- · · · ·		
H	· · · ·	U	· · -	7	- - · · ·		
I	· ·	V	· · · -	8	- - - · ·		
J	· - - -	W	· - -	9	- - - - ·		
K	- · -	X	- · · -				
L	· - · ·	Y	- · - -				
M	- -	Z	- - · ·				

Suggestions for Teachers:

Divide the class into small groups (two to five students) for practice. Have one student at a time in each group code a word and flash it on the wall or the side of a board or notebook that is propped up. The other students in the group should try to decode the word. Allow them to use the printed code sheet until they know the code. Make sure all students get practice at both sending and receiving messages. When they get proficient at decoding words they should code sentences, and eventually whole messages.

ILLINOIS
NATURAL
HISTORY
SURVEY
607 East Peabody Drive,
Champaign, Illinois
61820 USA

Bio Blitz

continued from front page

of Illinois, provided that. A Survey committee organized the event over a period of nine months. Many details associated with the event had to be dealt with in a relatively systematic way.

Fourth, it takes motivation and the desire to do something special. The Survey undertook the first-ever midwestern Biodiversity Blitz for several reasons:

—to determine the overall biodiversity of Allerton Park

—to bring the issue of biodiversity to the attention of Illinois citizens

— to showcase how biological surveys are conducted

—to provide a unique natural resource event to usher in the new millennium

—to break the temperate zone blitz record for species found in 24 hours,1,905 species found at Walden Pond in 1998.

All of the above came together at the historic Red Barn at Allerton Park. The goal was simple—to find as many different species as possible within the park. The fact that the Walden Pond record lurked on the horizon was also part of the motivation for our event. For 24 very special hours the Red Barn was turned into a taxonomy laboratory with wave after wave of scientists working at preparation and identification of specimens. In addition, field crews of ornithologists, mammologists, herpetologists, icthyologists, and malacologists surveyed Allerton for sitings or signs of organisms in their groups.

In addition to all the scientific work, a series of outdoor presentations on various topics were given for the general public during daylight hours on both days of the blitz. Each of the 10 presentations was well attended and allowed citizens to directly interact with the scientists. A further activity was field excursions whereby citizens could accompany scientists into the field and assist with their work. Perhaps the most popular excursion was mist-netting for bats. The participants were treated to the capture and release of two species of Illinois bats.

To record all this information in a systematic and scientifically valid manner required the modification of an existing database and setting up a portable computer network system within the Red Barn. Database entry people came from the Survey administrative staff and from a local high school. The 24 hours of intense biological labor resulted in a mass of data that overwhelmed the data entry folks for a time. Everyone left the event satisfied with their effort, but wondering if they indeed had the record. Although the final count is not yet in, the tentative number is over 2,000 species! In short, Allerton Park is one very diverse and special place.

Michael Jeffords, Center for Economic Entomology

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ILLINOIS NATURAL HISTORY SURVEY

Reports

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Winter 2002
No. 370

INSIDE

Responses to Nest Predation and Brood Parasitism in a Migratory Songbird

Birds have evolved life history traits that tend to maximize lifetime reproductive success, and these traits include behavioral responses to factors limiting reproductive success. Behavioral responses may be especially important for birds breeding in highly fragmented landscapes where increased nest predation and increased brood parasitism by Brown-headed Cowbirds can greatly reduce reproductive success.

I studied color-marked populations of Prothonotary Warblers (*Protonotaria citrea*) in the fragmented bottomland forest of the Cache River watershed during 1993–2000 to determine whether or not these birds responded to nest predation and brood parasitism in ways that reduced the negative effects of each. Experimental and nonexperimental data demonstrated that individual Prothonotary Warblers returned to sites between years in response to their reproductive success (as limited by nest predation). Between-year site fidelity increased with an increase in the number of broods produced with approximately 80% of double-brooded males and females returning. Individuals returned at rates of approximately 30% and 50% when they produced zero or one brood, respectively. Brood parasitism by cowbirds reduced the reproductive success of Prothonotary Warblers as a result of decreased hatching success of warbler eggs and decreased survival of warbler nestlings. The warblers accepted brood parasitism and did not choose nest sites inaccessible to cowbirds, defend nests during the egg-laying period, desert parasitized nests, or avoid returning to sites where they had been parasitized. The results of this research indicate that these birds may be able to avoid chronically high rates of nest predation by not returning to areas where nest predation eliminates nesting success. Prothonotary Warblers, however, may be especially vulnerable to ecological traps where rates of nest predation are low, levels of brood parasitism are

Two Prothonotary Warblers, brilliant yellow inhabitants of Illinois. **Photo courtesy of Bryan Holliday**

Continued on back page

The Role of Insect Flower Herbivory in Native and Restored Prairies

Several studies have shown that insect herbivory on an inflorescence can limit not only the number of seeds but also can influence seedling recruitment in a population, ultimately having an impact on the size of a population. However, the absence of insect herbivores can result in a plant species becoming very abundant and on some occasions weedy. In an ongoing study, the impact of insect flower herbivory (i.e., presence or absence) on the reproductive output and regulation of population size is being addressed using the prairie species *Eryngium yuccifolium* Michx. (Apiaceae), rattlesnake master (Fig. 1).

Fig 1. *Eryngium yuccifolium* Michx., rattlesnake master plant. **Photo by Brenda Molano-Flores, INHS CTAP Group**

Rattlesnake master is a very striking prairie species, having leaves similar to the yucca plant and prickly white flower heads (Fig. 1). This species can be found in the southeast portion of the Great Plains and is found in 80% of Illinois. In Illinois, particular interest is placed on this species because it serves as a food source for the state-threatened *Eryngium* stem-borer moth (*Papiapena eryngii* Bird [Noctuidae], Fig. 2). In addition, this species is considered to be a highly conservative species (i.e., found primarily in undisturbed tallgrass prairie). Although thought to be a conservative species, in some cases it can become extremely abundant in native prairies or even weedy in restored prairies. Several potential reasons for such abundance are high seed set, combined with abundance in the seed bank, and good germination. However, this does not explain why in other prairies, both native and restored, we find only a handful of rattlesnake master individuals.

During the summers of 1998 and 1999 while conducting a research project to determine different aspects of the reproductive biology of rattlesnake master, I discovered a lot of flower herbivory, up to 60%, in a native population. This differed from a restored population that had only 1% flower herbivory. As a result of this finding, several questions started developing: Do all populations (native and restored) of rattlesnake master have this flower herbivory? Do we find the same flower herbivores in all rattlesnake master populations? Is the lack of flower herbivory the reason for the extreme abundance of this species in some prairies? Can the size and degree of isolation of a rattlesnake master population determine the presence or absence of this flower herbivory? Do restorations of different ages have the same level of flower herbivory?

Fig. 3. Rattlesnake master flower head with evidence of herbivory. **Photo by Brenda Molano-Flores, INHS CTAP Group**

To answer these questions, I have been gathering data on 20 rattlesnake master populations in Champaign, Ford, Livingston, Vermilion, and Will counties. Ten of these populations are found in native prairies and 10 in restored prairies. Both native and restored populations range from a few individuals to thousands, and all populations are in isolated prairie fragments. In the case of restored prairies, I am using restorations that are 6 to over 25 years old. For each of these sites I am also collecting data on species diversity. At each site, I collect 3 flower heads from 20 individuals, when possible, and determine percent flower herbivory and percent fruit. In the process of determining percent flower herbivory and percent fruit set, I have discovered that many of the populations have some degree of flower herbivory (Fig. 3). This is detected by the presence of holes in the fruits or the entire ovary being gone. However, it is too early in the study to determine differences between native and restored prairies or patterns associated with size and age of restorations.

Fig 2. *Eryngium* stem-borer moth. **Photo courtesy of William Glass**

Why should we be spending time studying this plant-insect interaction? As with plant-pollinator interactions, plant-herbivore interactions can be used as an indirect way to measure success for prairie restorations. For example, if herbivores are contributing to the long-term population control of a species and they are found in our restorations, then it suggests that the restorations are resembling native prairies. So what was presumed to be negative interaction (herbivory) can be viewed as positive interaction and can be used as an indicator to determine the health of a prairie.

Brenda Molano-Flores, INHS CTAP Group

Turtle Research at the INHS Great Rivers Field Station

In North American aquatic ecosystems, turtles often make up a large portion of the biomass. Even so, relatively few long-term research projects currently examine life history and ecology of aquatic turtle populations. Programs conducted in Michigan (E.H. George Reserve) and South Carolina (Savannah River Ecology Laboratory) demonstrate the need for long-term studies of turtles.

Beginning in 1992, researchers at the INHS Great Rivers Field Station began to examine turtle demographics, reproductive ecology, and life history strategies. Primarily, studies focused on the red-eared slider (*Trachemys scripta elegans*) because that species is the dominant riverine turtle in Pool 26 of the Mississippi River, where this study was done. Nonetheless, data were gathered on eight other less commonly encountered species as well.

Demographic studies: Technicians of the fisheries component of the Long-Term Resource Monitoring Program collect large numbers of aquatic turtles in nets set to track fisheries resources in Pool 26. Size, sex, and specific identity data on these turtles are collected in the field. Moreover, many of these turtles are brought back to the laboratory where more detailed measurements can be made. After being individually marked, they are returned to their capture site. Recaptures allow population demographics for pool-wide backwater use to be determined.

Experiment in competition among turtles at the INHS Great Rivers Field Station. **Photo by John Tucker, INHS Center for Aquatic Ecology**

Reproductive ecology: Beginning in 1994, turtle studies were expanded to include a component on reproductive output. Studies are conducted by collecting nesting females at Stump Lake in Jersey County and in Swan Lake and Pohlman Slough in Calhoun County. These females lay their eggs in the laboratory where the eggs are then weighed, counted, and incubated. Data collected allow comparisons of reproductive output among years and between sites.

Red-eared slider albinos and normal clutch mates. **Photo by John Tucker, INHS Center for Aquatic Ecology**

We have found that reproductive output varies among years, with years following extensive flooding tending to coincide with lowered reproductive output. We have also found differences between sites in reproductive effort. At sites with extensive aquatic vegetation (an important food resource for aquatic turtles), the turtles tend to lay more but smaller eggs than do turtles from sites with little or no aquatic vegetation. The evolutionary implications of these findings are now under experimental examination.

Life history strategies: The eggs that female turtles lay hatch in our laboratory after incubation. Many of these hatchlings are then released at the site of their female parents. Some, however, are used in nondestructive experiments designed to examine life history strategies. Our main focus is to identify variables that influence hatchling survivorship. Thus, we have performed experimental releases each year beginning in 1995. Our findings suggest that larger hatchlings are more likely to survive than smaller ones. We also found that predation by birds is a major source of mortality in migrating hatchling turtles. Other experiments have examined responses to subfreezing temperatures, competition, and variable incubation environments.

Our efforts have resulted in research publications in general interest journals such as *Ecology*, *Journal of Evolution Biology*, and *The American Midland Naturalist*. Moreover, our findings have appeared in international herpetological journals such as *Journal of Herpetology*, *Herpetologica*, and *Copeia*. Overall, our findings have appeared in more than 50 publications in less than 10 years. Importantly, our program has also afforded graduate and undergraduate students opportunities to complete research projects. Student projects not only provide experience in field biology but also advance our understanding of chelonian biology.

John K. Tucker, Center for Aquatic Ecology

Soybean Aphids and the Search for Natural Enemies

The soybean aphid, *Aphis glycines*, was discovered in northern Illinois and southern Wisconsin in late July 2000. By September its presence had been documented in 11 states. This year, 2001, was the first opportunity to observe this species throughout an entire growing season and there have been many surprises. One of the first surprises was the discovery of large populations on the perimeter of where the aphid had been relatively abundant in 2000. In New York and Pennsylvania and the province of Ontario, where the aphid had not been recorded, early spring populations appeared, as they did in many areas of Minnesota, Wisconsin, and Michigan where it had been found but had not been abundant in 2000. In most of these areas, high populations developed and were sprayed with insecticides. By September it was known from southeastern North Dakota to one county in Virginia. It is clear that this aphid is here to stay and that it has the potential to become a serious pest of soybeans.

When exotic organisms like the soybean aphid arrive in North America, their populations may explode and they can become pests. Often this is because the natural enemies that kept populations under control in their native habitats are absent in their new home. One way of controlling exotic organisms is to search for these natural enemies in the native habitats and, after proper testing to insure these natural enemies will not also become pests, introduce them in our infested habitats. This is called classical biological control.

In July, one group of scientists from the University of Minnesota went to China and Bob O'Neil of Purdue and David Voegtlin of INHS went to Japan in search of natural enemies of the soybean aphid. The focus of these trips was to find small wasps that parasitize aphids. These tiny wasps, called parasitoids, kill aphids by laying an egg into the body of an aphid, the egg hatching into a larva that feeds on the inside of the aphid, eventually killing it. The mature larva spins a cocoon inside the aphid and turns into a pupa that emerges later as another adult wasp, one wasp from one aphid. When the parasitoid larva spins a cocoon inside the aphid body, the aphid takes on a puffed-up appearance and is called a mummy.

Soybean field with bamboo in background at Utsonomyia, Japan. **Photo by David Voegtlin, INHS Center for Biodiversity**

In Japan, collections were made by myself and Bob O'Neil in both cultivated (*Glycine max*) and wild (*G. soja*) soybeans at approximately 60 sites in the northern part of Honshu. Field size varied from plots with dozens of plants (e.g., backyard gardens containing soybean plants) to 50-ha fields (most fields this size were converted from rice paddies). Small blue/black mummies (aphelinids) were the most common parasitoid found in both wild and cultivated soybeans. Parasitoids were found in all sizes of fields and at both low and high aphid densities.

In China, scientists from the University of Minnesota made collections in Harbin, Changchun, and Beijing (eastern China). Soybean field size in China varied but fields were generally larger than those in Japan. Only cultivated soybeans were sampled for aphids, and only aphidiine parasitoids were observed and collected. These mummies have the color and texture of a brown paper bag. As in Japan these mummies were found in aphid colonies of all sizes.

Mummies from both Japan and China were brought back to a U.S. Department of Agriculture quarantine facility at Newark, Delaware. At present, the species from Japan, whose scientific name is *Aphelinus albopodus*, is being successfully cultured in quarantine. Before this parasite will be approved for release against the soybean aphid, it will have to undergo tests to demonstrate its host range for us to be certain the parasite will not itself become a problem.

Further trips are being planned to continue the search for natural enemies of the soybean aphid in the Asian region.

David Voegtlin, Center for Biodiversity

Effects of Excluding Birds on Illinois Prairies

Birds are conspicuous members of grassland ecosystems, as anyone entranced by the acrobatic and vocal territorial displays of Bobolinks can attest. However, the question remains, Do birds play any sort of significant ecological roles in grasslands? Existing data are contradictory. For example, based on their contribution to annual productivity (production of offspring, expenditure of energy, etc.) in shrub-steppe (shrubby grassland), ecologist John Wiens speculated that birds may be little more than "frills" in the ecosystem, not interacting with it in any particular way.

In contrast, several studies have found that grassland birds can significantly reduce the numbers of grasshoppers. Because grasshoppers can be abundant and voracious herbivores, their suppression has the potential to free grassland plant species from a major loss of photosynthetic tissue, which in turn may allow plants to increase their own annual productivity. This potential increased productivity may support a greater abundance and diversity of animals that ultimately depend upon primary production.

Gitogo Maina (Ph.D. candidate at UIC) vacuums insects with a Stihl blower/vac. **Photo by Chris Whelan, INHS Center for Biodiversity**

To address this issue, colleagues from the University of Illinois at Chicago and I set up an experiment in an ongoing prairie restoration experiment conducted at The Morton Arboretum in Lisle, IL. The original experiment was designed to look for effects of avian and mammalian granivores on initial prairie restoration establishment (effects of both birds and mammals were found). The main focus now is on how mammalian herbivores (voles) affect community composition and productivity.

Marius Van der Merve (left, a Ph.D. candidate at UIC) and author Chris Whelan in The Morton Arboretum prairie plots with bird exclosure cages. **Photo courtesy of Joel S. Brown, Professor of Biology at UIC**

In our experiment, we erected bird exclosure cages within the replicated prairie restoration plots. The cages are constructed with half-inch-diameter rebar, PVC plumbing pipe, and monofilament nylon gill netting. The mesh of the netting is large enough for virtually all insects to access the interior of the cage, but it is small enough to exclude birds. If birds significantly reduce the numbers of insects, then presumably herbivory should be of greater magnitude inside of cages than in comparable control areas outside of cages. If this is the case, then it is also possible that plants outside of cages will experience decreased insect herbivory, and in turn may experience elevated productivities.

To sample insects, we collected them with a gas-powered vacuum eight times during the growing season of 2001, with usually about two or three weeks separating collection dates. Insects were identified to Order (e.g., Orthoptera), counted, and returned to the site of capture. To sample herbivory and its potential effect on plant productivity, we examined all the stem leaves on individual plants of the species stiff goldenrod that were both inside and outside the cages. In addition to estimating loss of leaf tissue on each stem leaf of each stem of each individual, all flower heads were counted. Later, randomly selected flower heads will be collected and seed mass estimated.

Although the data have not yet been analyzed, several tantalizing findings seem apparent. First, on some sampling dates, but not others, more insects appeared to be captured inside than outside the cages. If this is so, it suggests that the effects of birds on insect population abundances may blink on and off during the growing season (this was also found in a similar experiment conducted in an oak forest in Missouri). Second, we found that the composition of the insect community could vary considerably between consecutive sampling periods separated by only two weeks. The changing insect community composition could be both a consequence and the cause of the variable bird effect. Third, although not insects, spiders were collected and counted. Spiders, which along with birds are also insect predators, usually appeared more numerous within cages. So when insect numbers were greater within cages, this is despite what appears to be increased spider predation within cages. If all of these impressions hold, our conclusion will be that birds, despite having low annual productivities themselves, are certainly more than just frills in these experimental communities.

Christopher J. Whelan, Center for Biodiversity

Species Spotlight

Mole Salamander

Michelle Garland

Collectively, salamanders of the family Ambystomatidae are referred to as mole salamanders, but it is *Ambystoma talpoideum* that is known commonly as the mole salamander.

The mole salamander, *Ambystoma talpoideum*. **Photo by Michael Jeffords, INHS Center for Economic Entomology**

Like the mole for which it is named, this salamander spends a great deal of its life underground. It might also be found wandering the forest floor on rainy nights, or under a log or among forest debris and leaf litter during the day. It is rarely seen outside the breeding season—December through February—and finding a specimen is often a matter of luck, unless one knows of a breeding site and keeps tabs on it throughout winter and spring.

Loose, moist soils are most suitable for burrowing and therefore the mole salamander is found primarily in wet bottomland and swamp habitats, flatwoods, and near floodplains and low-lying areas. Found throughout much of the Coastal Plain of the southeastern United States, it is in its northernmost U.S. range at the southern tip of Illinois. Here, the mole salamander finds refuge in the bald cypress and tupelo swamplands and sloughs and ponds of the Cache, Mississippi, and Ohio River valleys. Much of the swamp habitat has been drained and fragmented, but the remaining fragments are protected in state conservation areas, nature preserves, and the Cypress Creek National Wildlife Refuge. While its range in Illinois is limited to Jackson, Union, Alexander, Johnson, Pope, and Massac counties, the mole salamander is quite commonly found there.

The mole salamander, like many other amphibians, needs water for breeding. Shallow, heavily vegetated and fish-free temporary ponds provide the most successful breeding environment. Breeding sites are sometimes shared with marbled, spotted, or tiger salamanders. Adults make their move, often during heavy autumn and winter rains, to breeding areas for courtship and egg laying. Male salamanders do not have breeding calls like frogs and toads, but they can be distinguished from females because they develop a swelling around the cloaca (the internal chamber at the base of the tail that receives the digestive, urinary, and reproductive tracts) during breeding. After fertilization occurs, the female attaches 200–400 small eggs, in jelly-covered clusters (containing up to 35 eggs each), to submerged twigs and leaves. Breeding is completed in just a few days.

During summer or autumn, eggs hatch into gilled larvae resembling small fish. Young larvae feed voraciously on small zooplankton; as the larvae mature they consume larger aquatic invertebrates. They will eventually complete metamorphosis and leave the water to mature on land, returning to ponds only to reproduce. Most individuals will return to the same pond in which they hatched. In certain populations of *A. talpoideum* the larvae mature sexually before metamorphosis, remain aquatic, and reproduce while retaining their larval characteristics. These individuals are called neotenic (from the term neoteny, meaning the attainment of sexual maturity by an organism still in its larval stage).

One of the smaller members of the Ambystomatidae family, a typical adult mole salamander is three to four inches long. The limbs and broad, bluntly rounded head seem disproportionately large. It has 4 toes on forelimbs, 5 toes on hind limbs, and 10 or 11 costal grooves (a vertical groove along the sides of the body between the front and back limbs).

A. talpoideum is the least distinctive looking salamander of the family. Its soft, moist, scaleless skin is fairly uniform in coloring, ranging from muted bluish gray to nearly black with white, gray, or silver flecking. Often it will have a white edge along the top of the tail. The belly is gray with light blotches. Overall, it resembles the smallmouth salamander.

Adult mole salamanders eat beetles, centipedes, slugs, worms, and other invertebrates, much like their mammalian namesake.

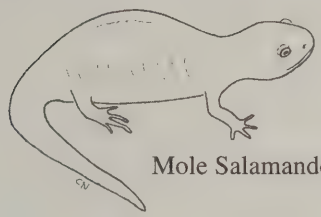
The Naturalist's Apprentice

Adaptations for Life Underground

Carolyn Nixon

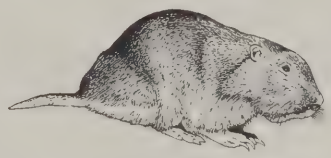
Adaptations for Life Underground

Many species of animals are adapted to burrowing underground. Below are just a few. Examine these pictures closely and list characteristics for each that you think may be adaptations for burrowing. Not all species will have the same adaptations, and some unrelated species may have similar adaptations. Try to find three characteristics for each of these species.



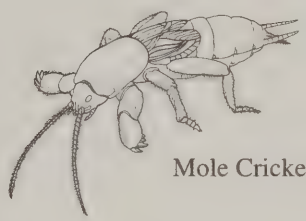
Mole Salamander

Pocket Gopher



Mole

Earthworm



Mole Cricket

Here are some animals that do NOT burrow. List characteristics of each that you think would make them poorly adapted for life as a burrower.

White-tailed Deer

Crane Fly

American Kestrel

For Teachers

Terms you may want to discuss:
- adaptation
- convergent evolution

Here are just a few adaptations for burrowing that some of the species have:
- large digging feet or claws
- small eyes
- streamlined body shape
- smooth skin or fur

Here are a few characteristics that make species poor burrowers:
- long and fragile legs
- delicate wings
- feathers (delicate and easily soiled)

Extensions

Look at pictures of other animals and discuss their adaptations to the ways they live.

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Warblers

continued from front page

high, and they are producing mainly cowbird young.

The Cache River Wetlands (CRW) bottomland forest restoration project in southern Illinois, including the Cypress Creek National Wildlife Refuge and Cache River State Natural Area, continues to provide a unique opportunity to incorporate the results of songbird research within the project area into management recommendations and the restoration plan. These recommendations will be validated in the long term with continued research as restoration proceeds. In the CRW area, our previous research on the bird community has established the importance of connecting and enlarging existing tracts of forest, of restoring and managing a wide variety of floodplain habitats, and of the importance of bottomland forests for birds during the winter. In addition, we now know that the rate and amount of water-level fluctuations during the breeding season influence the rate of nest predation, in turn affecting season-long reproductive success and ultimately influencing the patterns of site and territory fidelity of birds breeding in bottomland and swamp forests.

Continued research on the bird community in the Cache River Wetlands will expand our knowledge of how the restoration of hydrology in off-channel wetlands affects the diversity, abundance, and nesting success of birds within the bottomland forest ecosystem. The Prothonotary Warbler will continue to be the focal species for determining the success of hydrologic restoration and also for determining the effect of bottomland forest restoration on brood parasitism by cowbirds. This research will increase our ability to effectively and efficiently restore hydrologic processes and manage bottomland forests for those avian species that are dependent on functioning bottomland forest systems. The results of this research will have broad application in the Mississippi ecoregions and will assist with other bottomland forest restoration efforts in Illinois (e.g., Emiquon and the Illinois River project and the Kankakee River restoration project).

Jeff Hoover, Center for Wildlife Ecology

Author Jeff Hoover dwarfed by cypress in Cache River Wetlands.
Photo courtesy of Anthony Corso

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ILLINOIS NATURAL HISTORY SURVEY

Reports

Spring 2002
No. 371

INSIDE

INHS Studies of the Illinois River

This special issue of *Illinois Natural History Survey Reports* is published to highlight some of the biotic research and monitoring of the Illinois River ecosystem that illustrates the unique challenges and opportunities emerging for river restoration. The Illinois River basin is the only large watershed occurring almost entirely within our borders. The river starts southwest of Chicago at the confluence of the Des Plaines and Kankakee rivers and flows 272.9 miles across the state to the Mississippi River at Grafton. It is of unique importance because it acts as an aquatic gateway between the Great Lakes and Mississippi River ecosystems through a connecting canal built during the late 1890s. It is also unique because the river valley below Hennepin once carried the Mississippi River, and thus has a wider and more developed floodplain than might be expected for a river of its size.

Stephen A. Forbes, the founding Chief of the Illinois Natural History Survey, began studies of the Illinois River in the 1870s. He reported that 85% of the fish species found in the state occurred in the Illinois River. In 1908, fish yields in the lower Illinois made up 10% of the U.S. fish catch. Without a doubt this was one of the more productive river ecosystems in the nation.

There is renewed interest in the Illinois River system and efforts are now being aimed at rehabilitating the river to an ecologically functional system. This restoration must occur in the face of numerous human-induced disturbances associated with urban and rural land uses, dikes along the river proper, and locks and dams for navigation. The role of the INHS in this ongoing and long-term effort has been and will continue to be to provide a scientific basis for management and rehabilitation actions, and monitoring our progress will permit any midcourse corrections.

Although we should not delude ourselves into believing that we can or perhaps even should return the river to its pre-Columbian pristine state, the mighty Illinois and its contiguous lands can again act as a functioning ecosystem with many of its former aesthetic, recreational, biologically diverse, scientific, and ecological service values. The seven articles contained within this special issue typify some of the research that has and

The Illinois Natural History Survey has a long history of research on the Illinois River. Here the *Anax*, a floating laboratory staffed by INHS scientists, is anchored in the Illinois River in the 1930s. **Photo from INHS Image Archives**

Continued on back page

Data Management and the Illinois River Decision Support System

The INHS Illinois River Biological Station at Havana, Illinois (Havana Field Station: www.inhs.uiuc.edu/cae/ltrm/cae_hfs.html) is a remote installation of the INHS and the Illinois Department of Natural Resources (IDNR). The station hosts a Long Term Resource Monitoring Program (LTRMP) with major funding provided by the IDNR, the U.S. Army Corps of Engineers, the U.S. Geological Survey (USGS), and the U.S Fish and Wildlife Service.

The primary responsibility of Havana LTRMP staff is monitoring water quality, vegetation, macroinvertebrates, and fish along an 80-mile reach of the Illinois River. The mission of the LTRMP is to provide decision-makers with information for sustainable management of the Illinois River.

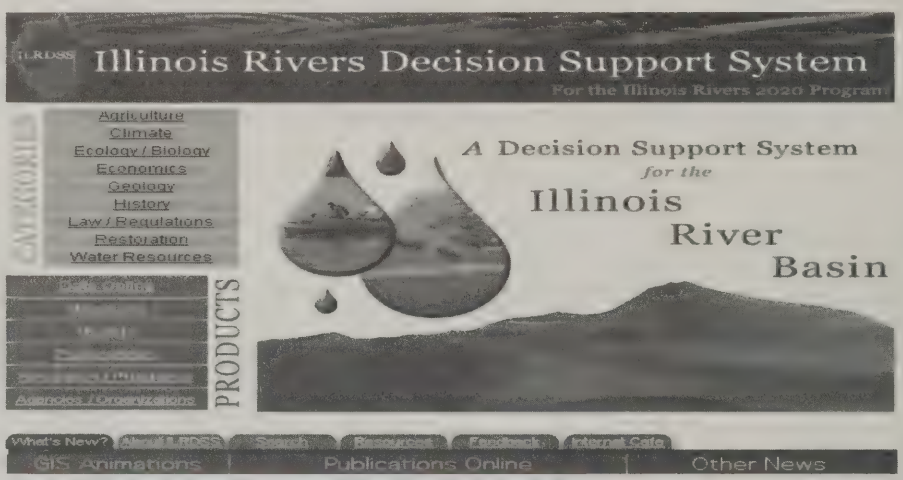

Fig. 1. Illinois River Decision Support System homepage.

The Illinois River Decision Support System (ILRDSS: http://ilrdss.sws.uiuc.edu, see Fig. 1) is a Web-based interface that provides access to high-quality information about the Illinois River and its watershed. It is currently supported by staff from several Illinois scientific surveys, but is largely an endeavor of the Illinois State Water Survey (ISWS). The ILRDSS began in 1999 as a resource for water quality and hydrologic model investigations. Its design has expanded to include information resources, modular databases, and simulation models to evaluate a wide range of impacts upon restoration activities and sustainability of the Illinois River.

This ILRDSS requires information from a variety of sources. Largely lacking at present are sources of biological data. The LTRMP staff at Havana generate large volumes of biological data and have done so for over a decade. Currently these data are maintained in an Oracle database at the USGS Upper Midwest Environmental Science Center (UMESC) in LaCrosse, Wisconsin. The latter provides public access to the data at www.umesc.usgs.gov/index.html that can be queried by year, GIS coordinates, organism (fish and invertebrates mostly), and so on. These data may be downloaded as a text file. Lacking at this point in the UMESC data management structure is the conversion of data into information useful in decision making. These data would be a valuable addition to the ILRDSS.

Funds associated with the ILRDSS now support a database developer/manager, Edward Chen, at the INHS. Until recently, he has been designing a database management structure for the Critical Trends Assessment Program, a statewide monitoring program consisting of both scientists and volunteers (http://dnr.state.il.us/orep/inrin/ctap/). Additional funding is now available for a Web programmer. This second position will help form the basis of a data management team. This latest development will enable the team to undertake additional data management objectives for the LTRMP staff at Havana. Negotiations are now under way between the team and LTRMP staff to

- create a relational database;
- create Web interfaces to host the database for input and output functions;
- develop automated, standard report templates for converting data to information for a range of uses and levels of understanding;
- design a Web geographic information system interface to visualize LTRMP data spatially.

The undertaking of these objectives will begin sometime in the spring of 2002. Having a centralized data management system at Havana will not only aid LTRMP staff in meeting their objectives for monitoring the Illinois River, but will also provide an integrated vehicle for delivering information to a wide range of users. Coupling this data source with additional information from the ILRDSS will provide the kind of integrated information needed to make management decisions for the Illinois River basin.

Dr. R. Edward DeWalt, Center for Biodiversity

The Freshwater Mussels of Illinois (The Mississippi, Illinois, Wabash, and Ohio Rivers)

Freshwater mussels (also commonly called clams or naiads) may be the most endangered group of animals in North America. Of the approximately 300 species found in North America, 70% are endangered, threatened, or in need of conservation. Because of their habitat and biology (river dwelling, long-lived, sedentary, filter feeders, dependent on fishes for reproduction), mussels are extremely susceptible to the cumulative effects of siltation and other forms of pollution and therefore are excellent indicators of water quality.

INHS biologists have conducted periodic surveys for freshwater mussels and by comparing the number of species found today with that of past studies, we have documented substantial reductions in diversity over the past 100 years. Recent surveys have indicated that many mussels that were once widespread and common in Illinois and throughout North America have been drastically reduced in number—16 species have been extirpated from the state of which 7 are globally extinct. Large rivers have been particularly hard hit because nearly all have been radically altered for navigation or otherwise modified to where they no long function as they did in the past. In addition, exotic species like the zebra mussel, thus far concentrated only in large rivers, have greatly impacted native mussels.

The Mississippi River historically supported 50 species of mussels. However, the construction of locks and dams has drastically altered the natural hydrology of the river and now it functions more as a series of lakes rather than a free-flowing river. That coupled with siltation from agriculture and poor land management has reduced the number of species to 33, a 34% decrease in species richness.

The Illinois River drains about two-thirds of the state and historically supported an abundant mussel fauna, which in turn supported a booming pearl button industry. Overharvest, the installation of locks and dams, chemical pollution, and siltation have all taken their toll on mussels. Of the 47 species once found in the river, only about 26 remain (a 45% decrease). However, parts of the Illinois River have undergone recovery in recent years and 18 species have repopulated the upper Illinois where they formerly had been extirpated.

The Wabash River is the longest free-flowing river in the eastern United States, and it is one of the few large rivers in the country that remains unimpounded and unchannelized throughout most of its length. The Wabash River mainstem in Illinois historically supported 67 species of mussels. Unfortunately, recent surveys indicate that the current number of species is 30 (a 55% decrease). Some of its larger tributaries (i.e., Vermilion, Embarras, Little Wabash) harbor the only populations left in Illinois of a few mussel species now missing from the mainstem.

Like the Mississippi and Illinois rivers, the Ohio River has been dammed and channelized for navigation. Many of the riverine species that once called it home have disappeared. Only 30 of the 51 species historically present in the mainstem Ohio remain today (a 41% decrease).

The genus *Epioblasma* has been particularly hard hit in the Wabash and Ohio rivers. Of the nine species in the genus once found in Illinois, only one (the snuffbox) remains. Dams, channelization, and siltation have destroyed the habitat of this group (riffle areas in large rivers).

Our surveys and others conducted throughout the eastern U.S. indicate that we have lost many mussel species and that many others are on the verge of extinction. The decline of freshwater mussels is probably due to a combination of factors, but siltation seems to be the primary cause in midwestern streams. Stronger soil conservation measures in lands bordering streams are needed to prevent surface runoff and to help curtail erosion. Keeping an intact vegetated border or riparian zone along streams is perhaps the most important thing we could do to prevent further losses of aquatic biodiversity.

Male (left) and female snuffbox (*Epioblasma triquetra*) mussel shells. The snuffbox is endangered in Illinois. **Photo courtesy of Christine Mayer and Kevin Cummings, INHS Center for Biodiversity**

Kevin S. Cummings and Christine A. Mayer, Center for Biodiversity

Waterfowl Populations in the Illinois Valley

The Illinois River valley historically has been one of the most important migration areas for waterfowl in the United States. An example of the dense concentration of waterfowl in the valley was given by Aldo Leopold, one of America's foremost conservationists, who reported that 3 million ducks were observed resting at both Crane Lake and Clear Lake near Havana during the late 1920s.

Mallards are the most common species of ducks in the Illinois Valley (Fig. A) and in North America. For a week in December 1944 nearly 4 million Mallards and American Black Ducks were documented on just seven lakes in the valley, including 1.5 million at Lake Chautauqua Refuge owned by the U.S. Fish and Wildlife Service. Frederick Lincoln, the first person to extensively band ducks in the United States, placed bands on Mallards in 1922 in the Illinois Valley and remarked that when all the other ducks are gone there will still be Mallards on the Illinois. However, because of human actions, the once-magnificent habitat of the Illinois River valley has become degraded, and the number of ducks passing through the valley each fall has steadily declined. A three-year moving average of the peak number of Mallards and total ducks aerially inventoried during fall on the Illinois River from 1948 to 2000 revealed a downward trend (Fig. B). Nonetheless, for the period 1955–1996, 20.6%, on average, of all Mallards wintering in the Mississippi Flyway were in the Illinois Valley during one day of their fall migration.

Figure A. Mallards feeding on seeds and invertebrates in the shallow waters of Lake Chautauqua Refuge near Havana, Illinois, in the fall of 1997. **Photo by Michelle M. Horath, INHS Center for Wildlife Ecology**

Food habit studies for Mallards from the Illinois Valley during 1979–1981 were compared with those from 1938 to 1940. The most notable finding was that during 1979–1981 Japanese millet, buckwheat, and grain sorghum—plants intensively managed for waterfowl—were major foods representing 10.6% of the diet. These foods were not found in the diet of Mallards during 1938–1940. Additionally, during 1979–1981 the aquatic plants coontail, longleaf pondweed, and common arrowhead no longer constituted an important part of the Mallard diet as they had during 1938–1940 (10.4%). Thus, in recent years, food items from domestic plants cultivated by hunting clubs and public areas have replaced the seeds of aquatic plants, which were no longer available in the valley.

The drastic declines of Lesser Scaups and Canvasbacks in the Illinois Valley are particularly noteworthy. These species were abundant in the valley before the mid-1950s. The food resources used by Lesser Scaups and Canvasbacks began to disappear from the upper Illinois River valley in the mid-1950s and have not recovered. Consequently the numbers of Lesser Scaups and Canvasbacks crashed and also never recovered (Fig. B). The largest concentration of Lesser Scaups observed during aerial inventories in the Illinois Valley occurred on food-rich Upper Peoria Lake, where 700,000 were seen in 1949. The peak number of Lesser Scaups recorded in the Illinois River region north of Peoria was 585,100 in 1954; 73,650 in 1955; 34,250 in 1956; and 10,075 in 1957.

The largest concentration of Canvasbacks aerially inventoried in the Illinois River valley since 1948 occurred on Upper Peoria Lake, where 95,000 were present in November 1953. The peak number of Canvasbacks recorded north of Peoria was 105,160 in 1952; in 1971, a maximum of 120 were observed there.

How much habitat will be necessary for waterfowl in the Illinois Valley in the future? The wetland and upland habitat restoration objective of the Upper Mississippi River and Great Lakes Region Joint Venture of the North American Waterfowl Management Plan identified a deficiency of 15,000 acres in Illinois in 1993. The Illinois Division of Waterways concluded in 1969 that to meet the potential waterfowl hunting demands in the Illinois Valley, it will be necessary to utilize all bottomlands not having a higher eco-

Continued on next page

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nomic use. The Division of Waterways recommended that at least 100,000 acres be under public management by 2020 and that at least 50,000 acres be under private management. Thus, satisfying these requirements would place about 35% of the Illinois River valley bottomlands under waterfowl management.

Because of the impressive numbers of waterfowl that frequented the Illinois Valley in fall and spring, a strong waterfowl tradition arose. For example, the waterfowl populations of the valley inspired some of the world's finest decoy carvers, call makers, and private club owners, caretakers, and members. The 100-mile stretch of the Illinois River between Beardstown and LaSalle probably had more call makers than any other place in the United States. The art of carving and painting lifelike wooden hunting decoys reached its height of perfection in Illinois, particularly in the Illinois Valley, between 1870 and 1940.

Private duck clubs began to appear in the Illinois Valley in the late 1800s when the river and bottomland lakes were still in rather pristine condition. Hunters from distant locations arrived at these private clubs by rail, steamer, launch, or cabin boat before the 1920s when roads and motor vehicles became more commonplace.

The clubs contributed significantly to sport hunting and the waterfowl resource. Management practices developed over the years by the clubs and their caretakers formed a solid base for modern waterfowl management. For example, the private clubs in the valley were among the first to initiate "rest areas" to hold ducks for improving hunter success. Almost all of the large private duck clubs (about 20) in the Illinois Valley in 1938 had refuges. They were also the first to set bag limits, ban automatic shotguns, stop spring shooting, and establish shooting laws. The private clubs continue to serve critical roles in providing rest areas and food for the fall and spring passage of waterfowl through the valley in addition to habitat and associated benefits for many other species of wildlife.

As we begin the twenty-first century, the continued importance of the Illinois Valley to waterfowl populations will depend upon the quality, amount, and distribution of a variety of wetland habitats associated with its floodplain as well as sufficient rest areas that will serve as focal points for the annual return of one of the mysteries of nature—migration.

Stephen P. Havera and Michelle Horath, Center for Wildlife Ecology

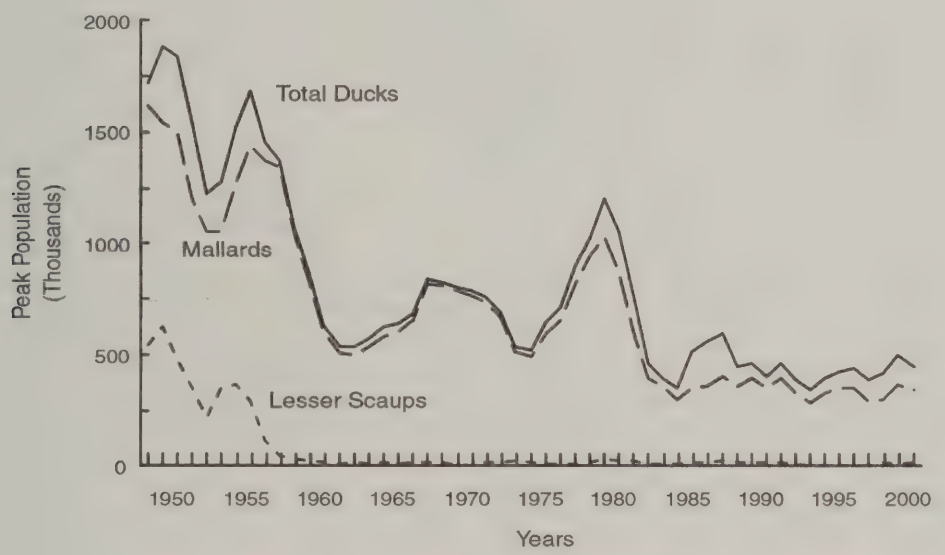


Figure B. Three-year moving average of the peak numbers of total ducks, Mallards, and Lesser Scaups aerially inventoried in the Illinois River valley during fall, 1948–2000.

Asian Carp in the Upper Mississippi River System

The introduction of zebra mussels to the Great Lakes and Upper Mississippi River System (UMRS) in the 1980s and 1990s increased public awareness of the problem of invasive species. In response, the United States Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act in 1990 and the National Invasive Species Act in 1996. Zebra mussels, however, are not the first, nor will they be the last, non-native species to invade our freshwater ecosystems. Introductions of fishes and other aquatic organisms into inland waters of North America have been increasing dramatically for the past 150 years. The invasion of the UMRS by several Asian carp species provides an excellent illustration of the history and continuing challenge posed by introductions of invasive species.

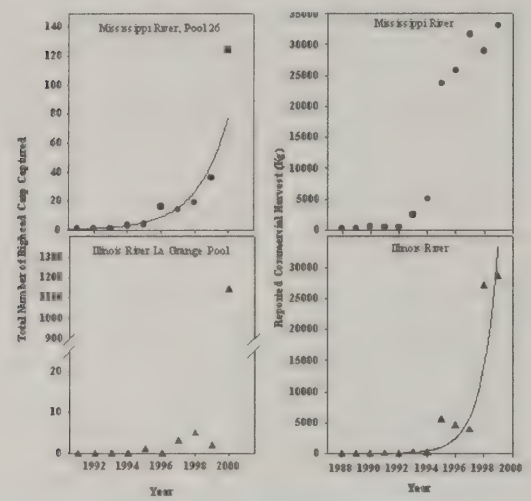


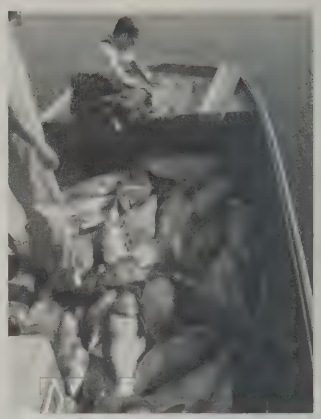
Fig. 1. Total number of bighead carp captured by researchers with the Long Term Resource Monitoring Program (left panels), and the total weight of bighead and silver carp captured by commercial fishers in the Mississippi and Illinois rivers (right panels). Lines indicate significant exponential trends.

Researchers at the INHS Great Rivers Field Station sample bighead and silver carp in the Mississippi River with trammel nets. **Photo by Eric Gitttinger, INHS Center for Aquatic Ecology**

Presently, four species of Asian carp are established in the UMRS and a fifth species is waiting in the wings. The first Asian carp species to become established in North American was the common carp (*Cyprinus carpio*), which was introduced in the 1800s by the U.S. Fish Commission to establish recreational and commercial fisheries. Today, common carp are abundant throughout the UMRS. Because this species was established so long ago, data are not readily available to demonstrate the effects of their invasion on native fish communities. Nevertheless, common carp are known to adversely affect aquatic habitats by uprooting vegetation and increasing turbidity.

Three additional species of Asian carp—grass carp (*Ctenopharyngodon idella*), bighead carp (*Hypophthalmichthys nobilis*), and silver carp (*Hypophthalmichthys molotrix*)—have become established in the UMRS during the past two decades. All three species were initially brought to the U.S. in the 1960s and 1970s for use in aquaculture, and became established in the UMRS through accidental and deliberate releases. Data from the Long Term Resource Monitoring Program and catch data from commercial fishers show that the abundance of these species, especially bighead and silver carp, has increased dramatically during the past few years (Fig. 1). Bighead and silver carp are filter feeders, consuming a variety of planktonic organisms, and are capable of significantly reducing zooplankton abundance in ponds and lakes. Because all fishes forage on planktonic organisms during their early life history stages, bighead and silver carp have the potential to adversely affect every species of fish in the UMRS and connecting aquatic systems.

If nothing is done to halt the upstream spread of bighead and silver carp in the Illinois River, they will soon enter the Great Lakes. A potential check on the upstream movement of bighead carp is the electric dispersal barrier being constructed on the Illinois Waterway near Chicago. However, this barrier was originally designed to stop the spread of the round goby (*Neogobius melanstomus*) from the Great Lakes to the UMRS, and it is unknown whether this barrier will be effective for bighead and silver carp. Researchers at the INHS Great Rivers Field Station and Illinois River Biological Station have initiated projects to assess dietary overlap of bighead carp with filter feeding fishes native to the UMRS, and the effectiveness of various barrier designs for preventing the spread of this invasive species to the Great Lakes.



Catch of bighead and silver carp from one 30-minute set of a trammel net. **Photo by Eric Gitttinger, INHS Center for Aquatic Ecology**

The black carp (*Mylopharyngodon piceus*) is waiting in the wings. This species is a molluscivore that was brought to the United States for use in aquaculture ponds. The previous invasions by Asian carp suggest that it is just a matter of time before this species becomes introduced and established into the UMRS, where it will pose a threat to endangered freshwater mussel populations. Once a non-native species successfully invades an ecosystem, it is often difficult or impossible to eradicate. Therefore, it is critical that state and federal management agencies make concerted efforts to stop the establishment and spread of black carp in the UMRS.

John H. Chick, Center for Aquatic Ecology

Exotic Plankton in Large River Systems

Invasive planktonic species face unique challenges in maintaining viable populations in river systems following initial establishment. Species with sessile adult and planktonic larval stages produce young that are carried downriver by currents, preventing them from settling out and replenishing the original benthic adult population. Species that are planktonic their entire lives produce young that drift downriver along with the adult parent population, neither stage being able to swim upstream against prevailing currents and repopulate upstream areas. Despite these challenges, invasive species representing both types of planktonic lifestyles are well established in the Mississippi and Illinois rivers. The methods by which populations are maintained may make species such as the zebra mussel amenable to control in large-river systems, whereas other species such as *Daphnia lumholtzi* are likely to prove nearly impossible to control.

In large-river systems such as the Illinois and Mississippi, zebra mussel populations are patchy, with upstream populations producing young that drift with the currents to replenish downstream populations. A system of populations connected by dispersal can be studied and described within a metapopulation framework. Metapopulation models have long been used in marine systems to help conservation biologists understand the size, number, and spacing of protected source populations (refuges) required to sustain the overall meta-population of desirable marine organisms. For the past several years, researchers at the Illinois Natural History Survey and the State University of New York have been developing metapopulation models for zebra mussels in large-river systems. Eventually, we hope to apply the inverse of conservation recommendations to affect control of zebra mussels on an ecosystem-wide level.

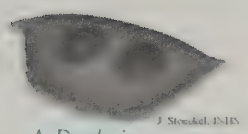
Zebra mussel veliger. **Photo by James Stoeckel, INHS Center for Aquatic Ecology**

Daphnia lumholtzi. **Photo by James Stoeckel, INHS Center for Aquatic Ecology**

In the Illinois River system, Lake Michigan likely serves as the ultimate source population that sustains riverine populations. Multidirectional currents and high retention times in Lake Michigan allow populations within the lake to be self-sustaining with some larvae passing through the lock and dams and into the Chicago River and canal system. During peak production times, as many as 13 million larvae per second flow from Lake Michigan into the Illinois River system. These larvae settle out and form adult populations which in turn produce larvae to seed and replenish zebra mussel populations farther downstream. In the upper Mississippi River, Lake Pepin likely plays a role similar to that of Lake Michigan. Adult zebra mussels are rare to absent above Lake Pepin, but increase dramatically below the lake. Larval abundance exhibits a similar pattern, with more than 100 million larvae per second flowing past sites below Lake Pepin on frequent occasions, and flux as high as 1.5 trillion larvae per second estimated during peak production.

Control of zebra mussels in the Illinois River might be possible by greatly reducing or eliminating the drift of veligers from Lake Michigan into the river system. An electric dispersal barrier is currently being constructed to reduce the exchange of exotic fish species between the river and Lake Michigan. Plans are under way to eventually develop a barrier that will also be effective against various planktonic organisms such as zebra mussel veligers. If proven effective in the Illinois River, similar control tactics could feasibly be applied to the Mississippi River, focusing on areas such as Lake Pepin.

Unlike the zebra mussel, control of *Daphnia lumholtzi* may never be possible. *Daphnia lumholtzi* seems better able to withstand the high summer temperatures and high sediment loads characteristic of Illinois River backwater lakes than can zebra mussels. These backwater areas can maintain populations of *D. lumholtzi* during periods of isolation from the main channel, and provide *D. lumholtzi* to the main channel during periods of connectivity. It is not likely that dispersal barrier technology could feasibly be applied to the myriad of floodplain lakes and sloughs along the Illinois River.



A *Daphnia lumholtzi* ephippium. **Photo by James Stoeckel, INHS Center for Aquatic Ecology**

Perhaps even more important than its ability to survive and flourish in the floodplain is the ability of *D. lumholtzi* to produce resting eggs, which are covered in a protective coating called an ephippium. Ephippial eggs can survive dessication and may remain viable for decades or even more than a century. Because they can survive out of water for long periods of time, ephippial eggs may be transported overland in all directions via various natural and human-mediated vectors. Even if the adult *D. lumholtzi* were somehow eliminated, hatching of ephippial eggs would reseed the populations for years to come. Although species such as the zebra mussel may be amenable to control in large-river systems, species such as *Daphnia lumholtzi* emphasize the importance of preventing exotic species from becoming established in the first place.

Jim Stoeckel, Center for Aquatic Ecology

Aquatic Resource Monitoring in the Upper Mississippi River Basin

The Upper Mississippi River System (UMRS) encompasses nearly 1,300 miles of waterway including the Upper Mississippi River, Illinois River, and several other important tributaries. This system is home to a wide array of fish and wildlife species distributed among diverse habitats such as channels, backwaters, sloughs, wetlands, and adjacent uplands. Historically, these floral and faunal communities have been important both ecologically and economically.

The Illinois River provides a good example of the economic value of this system because this river alone accounted for about 10% of the United States' inland river commercial fish harvest in the early twentieth century. However, management of the UMRS for human needs (e.g., navigation, flood control, etc.) has changed many of the natural dynamics of this ecosystem. This has created a tenuous balance between biological and human needs, the effects of which are not well understood. Despite these conflicts, the UMRS has been identified as one of a select few large floodplain ecosystems with enough integrity to possibly recover from these changes. To better understand the recovery process, long-term data are needed. Long-term information from large rivers are a rare but valuable commodity because they allow assessment of community responses to environmental conditions and also provide insight into management practices in these dynamic systems. Fortunately, such data do exist for the UMRS in the form of two projects currently being conducted by the Illinois Natural History Survey (INHS): the Long Term Resource Monitoring Project (LTRMP) and the Long Term Illinois River Fish Population Monitoring Project, also known as the Long Term Electrofishing project (LTEF).

Erik Harms and Josh Pierce sampling on the Illinois River. **Photo by Mark Pegg, INHS Center for Aquatic Ecology**

A barge on the Illinois River moving past Clear Lake (the backwater on the top). **Photo from INHS Image Archives**

Since its creation by the 1986 Water Resources Development Act (Public Law 99-662), the LTRMP has been conducted through a collaborative effort among the U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC), which administers the program, and

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five states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) with funding provided by the U.S. Army Corps of Engineers. The mission of the LTRMP is to provide river managers with the information needed to maintain the UMRS as a multiple-use large river ecosystem. The long-term goals of the program are to understand the system, determine resource trends and impacts, develop management objectives and alternatives, and manage the large amount of information collected.

Six field stations have been established throughout the UMRS to document long-term, system-wide ecological trends encompassing five separate 25–30 mile reaches of the Mississippi River, including Pool 26 studied by INHS staff at the Great Rivers Field Station and one 80-mile reach of the Illinois River studied by staff at the Illinois River Biological Station (La Grange Reach). Currently, the majority of LTRMP efforts are focused on monitoring fish, water quality, vegetation, and benthic macro-invertebrates. However, other research projects are also conducted as needed. Standardized sampling protocols are used for all field and laboratory work to facilitate spatial comparisons among sampling locations and to reduce sampling bias. The data collected through the LTRMP are subjected to a rigorous quality checking process, then warehoused at UMESC. These data and many other resources are then made electronically available to resource managers and the general public through an online data library. For further information on the LTRMP and access to the available data, please refer to the UMESC Web site at http://www.umesc.usgs.gov/ltrmp.html.

Paddlefish held by Mike McClelland. **Photo by Matt O'Hara, INHS Center for Aquatic Ecology**

Thad Cook conducting vegetation sampling along the Illinois River. **Photo by Josh Stevens**

The LTEF was initiated in 1957 by William C. Starrett to assess fish communities in the six mainstem reaches of the Illinois River. Since that time, INHS staff have continued collecting these data at 27 fixed sites and have established a nearly continuous data set on fishery information from the Illinois River. Standardized electrofishing methods have been used throughout the project to collect fish, and coupled with this standardized sampling regime, the relatively long period of record makes this a unique data set for lotic systems. These 40+ years of information have afforded an opportunity to track general fish population trends along the entire length of the Illinois River. Some of the more interesting results include a steady decline of common carp, *Cyprinus carpio*, and a marked increase in Centrarchid populations (e.g., bluegill, *Lepomis macrochirus*, and largemouth bass, *Micropterus salmoides*) throughout much of the river. These trends, especially the decline in common carp abundances, have been largely attributed to improved water quality over the period of record.

Human demands on rivers will likely continue to directly and indirectly influence aquatic communities along the UMRS, and the resulting data from these two projects have proven to be, and will continue to be, invaluable in providing insight into responses of aquatic communities to biotic and abiotic change. Further, these data are also beneficial in identifying future research and management needs as restoration efforts along both the Illinois and Mississippi rivers gain momentum.

Mark A. Pegg, Center for Aquatic Ecology

Species Spotlight

Paddlefish

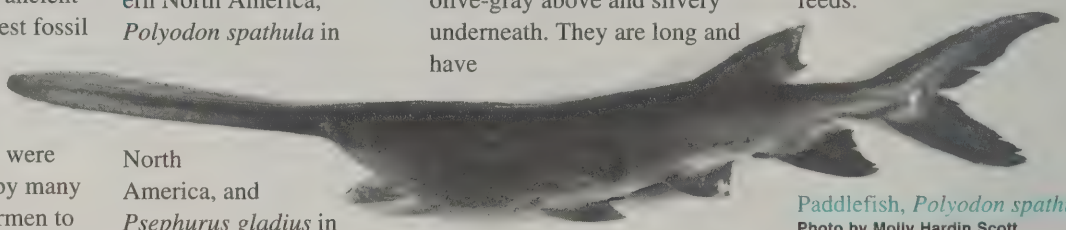
Susan Post

The paddlefish is a primitive fish—a survivor of an ancient fish fauna whose earliest fossil records date from the Late Cretaceous period (70–75 million years ago). Paddlefish were erroneously believed by many North American fishermen to be a kind of catfish. Its nicknames reflect the misidentification—duck-billed cat, shovel-billed cat, spoonbill, spoonbill cat, oarfish, or spatula fish. Early taxonomists described it as a "singular new genus of sharks" due to its tail and mostly cartilaginous skeleton. Pere Marquette, an early Illinois explorer, described it as ". . . a remarkable fish resembling a trout with a large mouth. Near its nose is a large bone shaped like a woman's busk, three fingers wide and a cubit long, at the end of which is a disc as wide as one's hand." Paddlefish are among the most primitive living ray-finned fishes and are related to the sturgeons. Five species are known: three extinct species from western North America, *Polyodon spathula* in North America, and *Psephurus gladius* in China.

The paddlefish, *Polyodon spathula*, is native to the Mississippi River basin and several Gulf Slope drainages where it occurs in warm, medium to large rivers with long, deep sluggish pools. It is also found in backwater lakes and bayous. By the early twentieth century in Illinois it could still be found in the seines of commercial fishermen on the Mississippi and Wabash rivers. On the Illinois River, however, it had already become rare. The paddlefish was formerly of great commercial importance in the state, not for its flesh, which was considered tough and inedible, but for its roe (eggs). Its roe were used in the making of caviar.

Paddlefish are bluish gray to olive-gray above and silvery underneath. They are long and have stout bodies, which are entirely naked or covered with tiny imbedded scales. They have large mouths and elongate and flattened snouts, which are in the shape of a long oar or spatula and are one-third the total length of the fish. Early accounts in the *Fishes of Illinois* (1908) state that paddlefish attained a weight of more than 150 pounds. At present most adults weigh less than 40 pounds and are around 40 inches in length. Paddlefish eat microorganisms by cruising open water with the lower jaw dropped while water is filtered across their large gill rakers, which strain out the plankton and insects.

There is some speculation on the purpose of the fish's unique snout. An early myth was that it was used for stirring up organisms on the bottom of the river. In reality the snout is covered with sensory structures so it may aid in the detection of food. Or perhaps the snout's broadly flattened form may serve as a forward-positioned hydrodynamic plane, stabilizing the fish due to the drag created by vast amounts of water entering the gaping mouth when the fish feeds.



Paddlefish, *Polyodon spathula*.
Photo by Molly Hardin Scott

Paddlefish reach sexual maturity by 7–12 years. The fish assemble in fast water over submerged gravel bars and spawn in the spring when water levels are high. The eggs are nonadhesive until they are fertilized. Once fertilized, the now sticky eggs sink to the bottom and stick to the first object they touch. Hatching is within nine days. Early development is rapid and the larvae are soon swept into downstream pools. Their snouts do not begin to grow until two to three weeks after hatching.

Today the paddlefish has been extirpated in parts of its North American range and is severely reduced in other parts due to impoundments, channelization, siltation (particularly of spawning grounds), pollution, and overfishing. They are a "biological treasure of the past and survivor of a primitive family" and hopefully this unique fish will continue to survive in the twenty-first century.

Fishermen on the Illinois River (ca. 1900) with a 7,000-lb. catch of paddlefish.
Photo from INHS Image Archives

The Naturalist's Apprentice

Ahead of Them All

Carolyn Nixon

Ahead of Them All

The Mississippi paddlefish is not alone in having special adaptations on its head. Below is a list of familiar Illinois animals that also have special modifications of the head. Match the animal with the description of the adaptation on the right.

1. White-tailed deer _____

2. Coyote _____

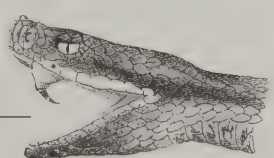
3. Cecropia moth _____

4. Northern flicker _____

5. Ant _____

6. Bat _____

7. Bald eagle _____



8. Rattlesnake _____

9. Bullhead _____

10. Eastern mole _____

11. Beaver _____

A. Beak is long, hard, and chisel-shaped. It is well adapted to chipping holes in wood.

B. Hard, branched head growths, called antlers, are used as a display to attract females and to spar with other males.

C. The moist, leathery nose is very sensitive to scents on the ground. It can help find prey and distinguish the scent of other individuals of its species that have been present in an area.

D. The large, strong incissor teeth can chew through wood.

E. Large, sensitive ears pick up clicking noises that are emitted from the mouth and bounce back after hitting an object. This is a form of echo-location.

F. Eyes are greatly reduced due to subterranean life, where they are of little use and would be easily damaged by soil. Also, the nose is soft and sensitive to feel and taste.

G. Long, fleshy whiskerlike growths are sensitive organs that can locate food in the mud.

H. Large, hooked beak is capable of tearing small pieces of flesh from a fish or other prey.

I. Long, jointed antennae are used to "feel" the path in front of them. They are able to detect a chemical trail left by others of their kind who traveled the path before them.

J. Large, fluffy antennae of the males have many chemical receptors that are able to detect even the faintest chemical cue from a female.

K. Pit in front of the eye is able to detect the body heat of warm-blooded animals.

ANSWERS: 1B, 2C, 3J, 4A, 5I, 6E, 7H, 8K, 9G,10F, 11D

ILLINOIS
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607 East Peabody Drive,
Champaign, Illinois
61820 USA

Illinois River

continued from front page

is being conducted on the river by Survey scientists.

One paper included in this issue of *Reports* highlights the long-term studies of waterfowl that have occurred in the watershed and documents the decline in waterfowl populations that has come with changes in the river. Another article highlights the changes that have occurred in freshwater mussel populations. Two papers discuss invasive species in the river, Asian carp and plankton species. One study on invasive species that is not discussed here is the monitoring that is occurring on the round goby and an evaluation of the effectiveness of an electric barrier to keep the species out of the Illinois River (it is moving downstream from Lake Michigan). There is also a discussion of two different long-term monitoring programs for fish and our contributions to the development of the Illinois River Decision Support System, an endeavor being led by the Illinois State Water Survey to bring together on the Web all pertinent data on the river.

The INHS has had a long-term commitment to studies on the valuable resources of the Illinois River. In 1894, Stephen A. Forbes established a field station for research and education at Havana, Illinois, which today is represented by our Forbes Biological Station. We also have two field stations on the river to carry out the USGS Long Term Monitoring Program (LTRMP), one located at Havana and the other in Brighton, Illinois. In addition, we have been working with the Department of Natural Resources and Environmental Sciences at the University of Illinois and with Lewis and Clark Community College to establish a Great Rivers Research and Education Center near Alton, Illinois. There is no doubt that the confluence of the Illinois, Missouri, and Mississippi rivers represents a unique location for the study of large rivers.

For Illinois, the Illinois River is a treasure, one that ranks with the Everglades, Chesapeake Bay, and the Columbia River in its ecological and societal importance. I would urge all citizens to rally around the state's conservation programs (from its successful Conservation Reserve Enhancement Program to Illinois Rivers 2020) aimed at the river's rehabilitation. The INHS continues to embrace its role as the provider of sound biological data on the Illinois River and on the changes that continue to take place in its biotic populations. We look forward to those efforts that will improve the health of the basin and encourage your comments on our efforts.

David L. Thomas, Chief of the Illinois Natural History Survey

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OIS
RAL
HISTORY
SURVEY

Reports

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Summer 2002
No. 372

INSIDE

New Endowment Honors INHS Researcher

In July 1950, R. Weldon (Larry) Larimore and Leonard Durham of the Illinois Natural History Survey (INHS) waded into Jordan Creek near Fairmount with what was then a newly developed electric seine. From the mouth of Jordan Creek where it empties into the Salt Fork of the Vermilion River, Larimore and Durham moved upstream for four miles systematically measuring and numbering each pool and ripple and collecting, marking, and releasing fish.

Dr. R. Weldon Larimore at the INHS Center for Aquatic Ecology uses newly developed electric seine and fish shocker in Jordan Creek in 1950. Photo from INHS Image Archives

This simple beginning to aquatic research on Jordan Creek more than 50 years ago came to spawn a legacy of data collection and significant publications that continues in the 21st century. In addition to Larimore and Durham, a number of budding INHS scientists cut their research teeth on Jordan Creek and went on to become leaders in aquatic biology. These include Quentin Pickering, William Childers, Carl Heckrote, David Menzel, Charles Goldman, Michael Duever, John Peterka, David McGinty, David Andrews, Gary Camenisch, and more recently Paul Angermeier, Isaac Schlosser, and Martin Jennings, among others. James Karr worked with several of these biologists and Jordan Creek data to develop the widely used Index of Biological Integrity. There are few places on earth that have been as intensively studied over time as Jordan Creek.

Dr. Larimore, who is still engaged in research at INHS, has recently been honored with an endowment in his name. The endowment entitled the "R. Weldon Larimore/Jordan Creek Endowment Fund" was created by his family to help perpetuate aquatic research on Jordan Creek. An annual award called the "R. Weldon Larimore/Jordan Creek Award" will be available to undergraduate and graduate students as well as INHS scientists who are involved in aquatic biology research on some aspect of Jordan Creek or aquatic biology research on other streams similar to Jordan Creek in central

Continued on back page

Some Recent Changes in the Illinois Flora

Our favorite records are always the ones of newly discovered native plant species within Illinois. Twenty-three additional native species have been found in the state during the past 20 years. An examination of the list of 23 plants allows very few generalizations that could be viewed as trends reflecting floristic changes. Eleven of the newly found species are at or near their continental northern or northwestern limits of range in Illinois, nine species found are at or near their southern limits of range, and the remaining four are well within their expected range in the state. Therefore, we cannot say that the new discoveries show any significant movement or change in the flora relating to climate or environmental disturbance.

Our least favorite information concerns the native plants that we conclude have been extirpated from the state. There may be some apparent trends reflected in the listing of the 64 species of plants that appear to have been extirpated from Illinois during the same time period. Certainly, the first observation is that this is a very large number of plants to disappear completely in a state in a relatively short time, and we are very concerned about it.

Trends of mass extinction are being seen around the entire planet. Among the 64 native plants that have not been seen in Illinois for many years, despite searches, and which may no longer exist in the state, 31 were at their continental northern range limits, 18 were near their continental southern range limits, 9 were at their central-western range limits, 1 was at its eastern range limit, and 5 were well within their expected ranges in Illinois.

Despite our fears of global warming, the data reveal that more species (48% of the total extirpated) with southern affinities have disappeared from our flora in the past 20 years than species with northern affinities (28% of the total extirpated). We might have expected that the plants vulnerable to heat would have decreased at a greater rate than those that thrive in warmer climates, if global warming was the primary reason. However, the reason for the greater perceived loss of southern species in Illinois may have been for reasons completely unrelated to changes in temperature. One normally finds very specific local causes of local extinction when looking for reasons for the loss of individual species, and this is certainly true in Illinois; each loss has a unique local cause. However, using our often forgotten but useful principle derived from Occam's razor that a simple explanation may be closer to the truth than a complex one, it may be that because there have been more field botanists searching for plants in the Chicago area than in extreme southern Illinois (an easily documented fact based partly on population densities and financial support), more northern species have been sought after and monitored than have southern species. Therefore, assumptions have been made that more southern species have disappeared when, in fact, we simply lack data on them.

Three-leaf rosinweed (*Silphium trifoliatum*), a recently discovered native plant in Illinois. Photo by Steven Hill, INHS Center for Biodiversity

Back on the brighter side, some native plants that were formerly thought to have been eliminated from the flora have been rediscovered during the past 20 years. This includes 14 species that have been found after extensive searches by field botanists during this period. The predominant group of plants that has been rediscovered is a group of nine species at their southern range limits (in effect, plants in northern Illinois). Three of the other rediscoveries were at their northern range limits, one was at its western range limit, and one was at its eastern range limit in Illinois. Again, it is hard to explain why cool-climate species have been (or persist) at a higher frequency than species with southern affinities in a time of global warming, unless one were to propose that there are more people hunting for these plants in the Chicago area than in the southern counties of the state (an explanation that I tend to support!).

One of the important results of our field surveys throughout the state during this period has been increased data on rare native plants that are more common than we previously realized, and this has allowed for the removal of 18 plants formerly listed as threatened or endangered within the state from that list. The plants that have been found to be more common than previously thought and that have been removed from the official Illinois list of protected species are seven plants near their northern limit of range, five plants near their southern limit of range, one at its western range limit, and five that were well within their range in Illinois but just were not known very well until recently.

How has the flora of Illinois changed in the past 20 years? We have been shocked to discover that 64 kinds of native Illinois plants known to our forefathers may have been lost from the state forever. We have been pleased to find that 23 kinds of native Illinois plants that we did not know were here, are actually here. We have found that 18 native plants, which we thought we were about to lose, are actually relatively secure here. We have found that 32 non-native plants from outside of Illinois have begun to find a home here, and that at least 4 of these have found it to be an especially good home and have begun to spread. Finally, it appears that because of the relatively small number of field botanists in the state and because of the realities of population centers and financial resources, we are also losing ground in our ability to actually record the numerous changes occurring on a regular basis in our botanical landscape, particularly in southern Illinois.

Steve Hill, Center for Biodiversity

Effectiveness of Crop Rotation on Corn Rootworms

Since the early 1990s, a behavioral adaptation to crop rotation by the western corn rootworm has jeopardized crop rotation as a management practice for this pest. Beetles that once stayed in corn to feed and lay their eggs now leave cornfields to deposit eggs in fields of soybean and other crops. By laying their eggs in other areas, female beetles assure that some of their eggs will hatch where corn will be grown the following spring (larvae can only survive on the roots of corn and a few grassy weeds). This ability of the western corn rootworm to circumvent crop rotation has forced farmers in east-central Illinois, northern Indiana, southwest Michigan, and western Ohio to apply soil insecticides to their first-year (rotated) corn.

To monitor the magnitude of adult western corn rootworm movement from corn into soybean fields and to track changes over time, we have established beetle traps in pairs of adjacent corn and soybean fields at five sites in Illinois. Since 1998, traps have been established at a site near Urbana (Champaign County) in east-central Illinois where western corn rootworms are a problem in first-year corn, and at four remote University of Illinois Field Research Centers located outside the area where western corn rootworms are a problem in rotated corn. These remote sites are located near Shabbona (DeKalb County), Monmouth (Warren County), Perry (Pike County), and Dixon Springs (Pope County). On-site cooperators at each Field Research Center deploy traps by early July in a pair of adjacent corn and soybean fields. Traps contain an insert coated with insecticide and powdered squash, a feeding arrestant. Rootworm beetles enter the traps, feed on the squash powder, and in the process ingest a lethal dose of the insecticide. At each site, a line of 10 equally spaced (10–30 meters) traps are deployed perpendicular to the interface of the corn and soybean fields. Traps in soybeans are attached to posts at canopy level while traps in corn are attached directly to stalks at ear height. Beetles are collected from the traps and the inserts are replaced weekly through early September.

In 1998, although western corn rootworm adults were trapped in corn at all sites, they were scarce only in soybean field traps at the four remote sites. In Champaign County, beetles were initially detected in corn and remained most abundant there for three weeks. Thereafter, western corn rootworm population densities increased in soybeans and rapidly exceeded those in corn. Western corn rootworm movement into soybeans occurred at fairly low beetle densities and even while fresh corn silks were available. The DeKalb County site differed from the other remote sites in 1998 in that the soybean border trap caught nearly as many beetles as traps in corn. The 1999 results were similar to those from 1998 except in DeKalb County, where total western corn rootworm capture in soybeans equaled that in corn. In 2000 and 2001, the pattern of very few western corn rootworms being captured in soybeans in Warren, Pike, and Pope counties was again observed. As was the case in 1999, total beetle capture in soybeans was about the same as in corn at DeKalb County. Capture of western corn rootworms in soybeans again exceeded that captured in corn at Champaign County in 2000 and 2001.

A rootworm trap in the soybean canopy. **Photo courtesy Eli Levine, INHS**

High western corn rootworm beetle abundance in soybean fields continues to distinguish problem from nonproblem areas. The western corn rootworm strain that lays eggs outside of cornfields is spreading very slowly from its origin in east-central Illinois to the north and west. Adult western corn rootworm movement patterns from corn into soybeans in DeKalb County now matches those of problem areas like Champaign County. Warren, Pike, and Pope counties are currently unaffected by the new strain; crop rotation there remains an effective pest management practice for limiting western corn rootworm injury to corn roots.

This project was funded in part by the Illinois Council on Food and Agricultural Research and the Illinois Soybean Program Operating Board.

Eli Levine, Joseph L. Spencer, Timothy R. Mabry, and Scott A. Isard, Center for Economic Entomology

Emerging Issues in Catch-and-Release Angling

For years, recreational anglers have been releasing fish alive following capture by rod and reel. Catch-and-release of fish has been considered to be a logical means of sustaining recreational fisheries. However, there is a growing body of literature that details the negative effects of catch-and-release angling. Furthermore, in some jurisdictions beyond America, laws have been enacted that prohibit the release of fish after capture due to animal welfare concerns. Research scientists in the Center for Aquatic Ecology have been engaged in extensive research directed towards understanding the sublethal consequences of catch-and-release angling. Beyond characterizing the negative consequences of catch-and-release, we focus on how to minimize the sublethal disturbances to fish and maximize survival. Below we describe a series of completed and ongoing studies that highlight the range of issues that we are assessing and disseminate some preliminary results.

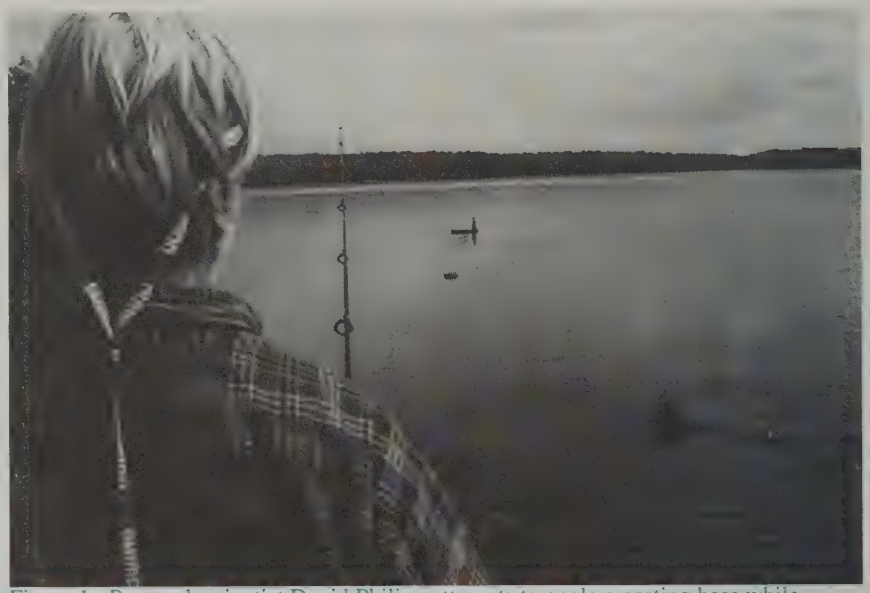


Figure 1. Research scientist David Philipp attempts to angle a nesting bass while graduate student Emily Grant monitors nest predation and behavior of the parental male bass by snorkeling. **Photo from INHS Image Archives**

There is a large body of research examining the injury and mortality resulting from different terminal tackle; however, recent development of new terminal tackle provides opportunities to assess their conservation benefits. A recent example is a study we conducted on the effects of circle hooks on hooking injury and mortality of largemouth bass. Circle hooks differ from conventional "J" style hooks in that the point of the hook is perpendicular to the shank. In marine fisheries, circle hooks have reduced mortality and injury. However, our freshwater research on largemouth bass suggests that circle hooks provide limited conservation benefits compared to "J"-hooks. A confounding variable is that circle hooks catch about half as many fish as conventional "J" shaped hooks.

Sublethal physiological disturbances associated with catch-and-release angling can be quantified and used to evaluate the effects of different angling practices and scenarios (e.g., water temperature, degree of exhaustion). In one study, we monitored cardiac activity of largemouth bass exposed to angling across a range of temperatures. The magnitude of the disturbance was strongly influenced by water temperature. As water temperature increased, fish took longer to recover from the disturbance. We also have assessed the effects of livewell confinement on largemouth bass and determined that fish activity in the livewell increases during wave conditions and that even short-duration air exposure can drastically delay recovery. Recently we have collaborated with a team of scientists at Queen's University in Ontario to link our research using cardiac monitors with more conventional blood and muscle biochemistry.

Feeding is an essential activity for fish. Evidence suggests that surprisingly small interruptions in food consumption may have negative consequences for growth. We examined the effects of simulated angling tournaments on largemouth bass feeding rates. Control fish consumed half of the prey introduced into their tank within the first minute, whereas those fish exposed to either 21 or 26°C consumed half of the prey at 8 and 25 hours respectively. Using these empirical data, we can run bioenergetics simulations to estimate the long-term (month, year, lifetime) consequences of tournament stressors on growth of fish.

Perhaps the most challenging aspect of catch-and-release angling to quantify is the fitness implications of such activities. Our labs have been addressing this issue on several fronts. Lakes in Illinois and Ontario are snorkeled extensively during the bass spawning period to monitor the success of parental nest-guarding males exposed to different capture scenarios (Fig. 1). We also use experimental ponds at INHS field sites to conduct controlled fitness manipulations. A recent study conducted by our group determined that exposing male and female fish to a simulated angling tournament prior to spawning resulted in spawning delays, the production of smaller fry, and the production of fewer individuals. We are currently undertaking a follow-up study to examine the mechanisms underlying the negative consequences.

These examples of some of our current research activities outline some of the major issues associated with catch-and-release angling. By providing anglers and fisheries managers with defensible data, we can help to ensure the sustainability of recreational fisheries in Illinois and throughout North America.

Steven J. Cooke, Michael Siepker, Kenneth Ostrand, David Philipp, and David Wahl, Center for Aquatic Ecology

What Happened to the Franklin's Ground Squirrel?

"I remember seeing them a lot when I was a kid. Where did they go?" "Those things used to be all over the place 30 years ago, but I haven't seen any around in quite some time." "During my 20 years as a wildlife biologist, I have only seen this species once." These comments are typical in reference to the Franklin's ground squirrel. It seems to be one of the many species in the Midwest that has become uncommon over the last several decades.

The Franklin's ground squirrel is a rather secretive critter. It can most often be found in tall, dense grassland vegetation and rarely spends time in open areas. It is slightly larger than its more common cousin, the thirteen-lined ground squirrel, and its coat is gray with no striping. At first glance it might be mistaken for a gray tree squirrel but the Franklin's has a smaller, narrower head and its tail is shorter and less bushy. It feeds primarily on plant matter but will also consume insects, carrion, and bird eggs.

The Franklin's ground squirrel can be found throughout much of the Midwest, from central Kansas to Indiana and northward through the Dakotas to Manitoba, Canada; however the species appears to be on the decline in a large portion of its range. Indiana, Wisconsin, and Iowa have awarded the Franklin's ground squirrel conservation status and wildlife biologists in Missouri have expressed concern over the species. In Illinois, these ground squirrels historically ranged throughout most of the northern two-thirds of the state but a lack of recent sightings has led to concern over their fate here as well.

In 2001 Joyce Hofmann (Center for Biodiversity), Ed Heske (Center for Wildlife Ecology), and I conducted a mail survey of 166 wildlife professionals throughout Illinois in order to gather information pertaining to the current status of the Franklin's ground squirrel. Only 9 of the 77 respondents knew of currently existing populations, describing a total of only 11 individual colonies. Forty-four areas of possible occurrence were also described based on unconfirmed sightings, the existence of historical records, or the existence of appropriate habitat. Based on this information, I conducted live-trapping surveys at 24 sites of suggested current occupancy and found Franklin's ground squirrels at only 2 of them.

Franklin's ground squirrel. **Photo courtesy of Jason Martin, INHS**

Loss of appropriate habitat has been cited by many as the cause of the decline of the Franklin's ground squirrel. The loss of grassland and prairie habitat to agriculture has been well documented; however the reason for this species' decline may not be as simple as sheer habitat loss. Many of the areas I surveyed that did not contain the species still appeared to have appropriate ground squirrel habitat. So, if appropriate habitat still remains to some degree, then why is the Franklin's ground squirrel not as common as it used to be? The answer probably has to do with the current overall structure of the remaining grasslands.

The remnants of the once-vast contiguous prairie system exist today in a highly fragmented state. As these habitat patches decrease in size they become less capable of supporting self-sustaining wildlife communities due to decline in resource availability and increasing competition for what little remains. Only generalist or highly mobile species that are capable of utilizing resources from multiple patches and habitat types are able to adapt to this new landscape. Further complicating the situation is the lack of connectivity between the remaining grassland patches, which for the most part exist as isolated islands in a sea of agriculture. Habitat corridors between two or more patches may provide a lifeline through which animals from each patch may travel, thereby increasing resource availability and providing a means of maintaining genetic fitness through the exchange of individuals.

Franklin's ground squirrel, given its preference for thick vegetation, may be unlikely to cross the expanses of agricultural fields, urban areas, and mowed roadways that separate grassland patches. This would leave each colony isolated, and thus more vulnerable to extirpation. Currently this scenario, although probable, is only hypothetical. My research is beginning to explore the effects of fragmented habitat structure on Franklin's ground squirrel. During the summer of 2002, I will be radio-tracking juvenile squirrels throughout their dispersal in order to examine movement patterns and specific habitat usage.

Habitat fragmentation and isolation may be only one contributing factor to the species' decline. Issues such as interspecific competition, increased predation rates, and changes in overall habitat quality are probably involved as well. However, management on a regional scale focusing on landscape issues such as the consequences of habitat fragmentation ultimately may better serve to protect the Franklin's ground squirrel rather than small-scale management of individual populations.

Jason Martin, Center for Wildlife Ecology

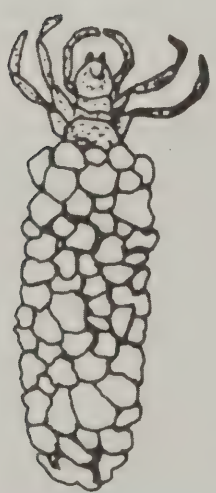
Species Spotlight

Caddisflies

Susan Post

"Stretched over the brooks, in the midst of frost-bound meadows, we may observe the submarine cottages of the caddisworms, the larvae of the Plicipennes; their small cylindrical cases built around themselves, composed of flags, sticks, grass, withered leaves, shells, and pebbles, in form and color like the wrecks which strew the bottom, — now drifting along over the pebbly bottom, now whirling in tiny eddies and dashing down steep falls, or sweeping rapidly along with the current, or else swaying to and fro at the end of some grass-blade or root."

Henry David Thoreau



Caddisfly larva with case. **Drawing from INHS Image Archives**

Thoreau is describing the larvae of caddisflies, an insect order familiar to fly-fishermen and aquatic entomologists alike. Caddisfly adults are moth-like and have two pairs of black, gray, or brown wings that are held rooflike over the body. Their wings are covered with hairs instead of scales and they have relatively long, slender antennae.

Caddisfly larva without case. **Photo from INHS Image Archives**

These insects are closely related to the butterflies and moths (Lepidoptera), but they are adapted for an aquatic life in the immature stages.

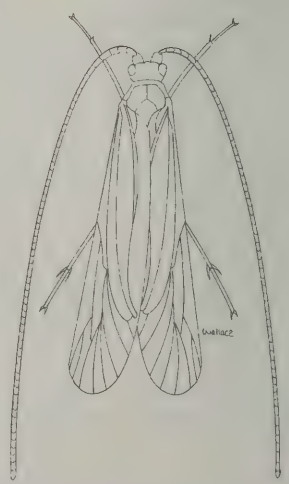
Caddisflies belong to the insect order Trichoptera, which means hairy wing. It is a large insect order with over 1,200 species in North America; 184 species are found in Illinois. The common name "caddisfly" comes from a Middle English term meaning bits and pieces of worsted yarn and refers to the larvae and the way they make their unique homes. Other common names include shadflies, sandflies, traveling sedges, caddis worms, and periwinkles.

Caddisflies have complete metamorphosis (different adult and larval stages). Eggs are laid in the water on aquatic plants, in overhanging vegetation, or at the shoreline. The eggs hatch into larvae, which are elongate, and 2–40 mm in length. They have chewing mouthparts and small, simple eyes. Only the forward part of the larval body (head, thorax, and legs) is hardened. The remainder is soft and flexible. As soon as the larvae hatch they begin construction of their "homes." The larvae construct an assortment of portable cases in which to house and protect themselves. The most studied and fascinating aspect of caddisfly biology is the form and behaviors relating to the cases in which they live.

The larvae use stone, sand, pebbles, or twigs to construct their houses and silk to hold it together. These cases are so distinctive that larvae can be recognized and identified by their cases alone. The larvae anchor themselves in the case with hooks at the tip of the abdomen and as the larvae molts the cases are enlarged by adding material to the entrances. There are usually five larval instars.

The majority of the larvae eat algae, diatoms, and other aquatic vegetation. However, a few larvae are carnivorous and instead of making a "house," these larvae are free-living and spin nets which they anchor to vegetation and use to seine for insects and crustaceans. To complete development the larvae seal the case (house) with silk, spin a cocoon, and pupate inside. About a month later the pupa swims up to the water surface, finds a rock or log to settle on, and emerges as an adult. Once the adult emerges it quickly flies away from the water. The adults can live 1–2 months and are usually found in damp woods, wetlands, and riparian areas.

Caddisfly larvae are common bottom fauna in most freshwater environments and they occur in association with all substrate types. Their cases and retreats are seemingly well-adapted for camouflaging and protecting them from predators; however, both adults and larvae are part of the diet of many sport fish (trout can consume case and all). While caddisflies are not as important as mayflies to fly-fishermen, they are the models for the Grannom, White Miller, Adams, and Grizzly King, all flies used by fishermen in North American waters.



Caddisfly adult. **Drawing from INHS Image Archives**

The Naturalist's Apprentice

Build a Caddisfly Larva and Case

Carolyn Nixon

Materials for each caddisfly and case

- 3" x 5" colored index cards
- Double stick carpet tape ($1^1/_2$" wide), two 4 1/2" sections, plus one 4" x 1/4" strip
- Round-head clothespin
- 12" pipe cleaners (or chenille stem), cut into three 4"-long pieces
- Assortment of dried peas, beans, pasta, lentils, etc.

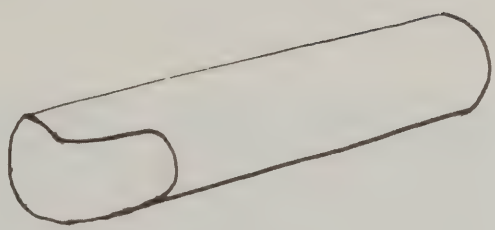
Tools

- Scissors
- 6"-long section of 5/8" dowel
- Fine-line marker

Construction

Caddisfly Case

1. Remove the backing from one side of two pieces of carpet tape and press them down, side by side, on one side of the 3" x 5" card. Apply the narrow piece of carpet tape to one long edge on the opposite side of the card.



2. Using a dowel, roll the 3" x 5" paper lengthwise, with the wide strips of carpet tape to the outside.

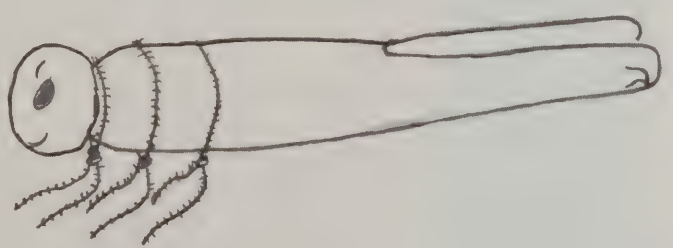
3. Pull the backing sheet off the narrow strip of carpet tape and pull back the covering of the tape along one long side of the wider tape. Stick the two long edges together with the narrow tape on top, so that tape sticks to tape, overlapping by about $^1/_2$". This will create a tube.

4. Cut a notch in one end, about 1" long, cutting out about 1/3 of the diameter of the tube.

5. Remove the protective covering from the rest of the tape (sticky side should be out).

6. Stick various objects (beans, peas, etc.) to the exterior of the case to create a caddisfly nymph home. These will represent the twigs, pieces of plants, sand, and pebbles that the caddisfly larva uses to build its case.

Caddisfly Larva



1. Obtain a clothespin, and beginning in the groove just behind the "head," wrap each section of pipe cleaner around the body once and twist it tight where they overlap. Use the three pieces of pipecleaners to create six legs. Spread the ends out to resemble legs.

2. With the legs facing down and the head facing you, draw two eyes and short antennae on the head of the clothespin. Also draw a hook on each of the legs of the clothespin. These will be the prolegs.

3. The final step is to inset the larva into its case, rear-end first, with the legs nestled in the notch.

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New Endowment

continued from front page

Illinois. The endowment fund will be administered by the University of Illinois Foundation. A three-person committee appointed by the Chief of the INHS will choose recipients of the award. Award selection shall be based on research proposals submitted by interested students or INHS researchers. Annual awards will be made in increments of $500 (e.g., $1,000, $1,500, $2,000, etc.) while any excess net income will be added to the principal of the fund.

Anyone wishing to donate to the fund may pick up a form from the INHS Distribution Office in room 172 of the Natural Resources Building or contact the UI Foundation at (217) 333-0810. The Illinois Natural History Survey is providing a total of $2,000 to match gifts given by Survey staff. Survey staff who want to contribute to the endowment fund should send their donations to Chief Financial Officer Sue Voegtlin at 176 NRB and she will forward the donations and matching INHS funds to the UI Foundation.

To kick off the R. Weldon Larimore/Jordan Creek Endowment Fund, Dr. Larimore's wife Glenn E. and sons Richard, Kenneth, and Michael organized and hosted a celebration on June 15. Fittingly, the celebration, attended by many family, friends, and colleagues, was convened at the Larimore family cabin on a private lake near Jordan Creek. Good company and great food topped off with hiking, bird watching, and canoeing made a memorable event for all. Perhaps the most intriguing fashion statement of the day was made by Glenn E. Larimore who sported a fab custom-created necklace of bones from the male raccoon reproductive anatomy.

Dr. Larimore has the distinction of being one of the longest serving employees of the Survey. He began his tenure at INHS in 1946 and has been associated with all but one of the Survey Chiefs (Stephen Forbes) in the history of this organization. Interestingly, our current Chief, David L. Thomas, was a former student of Dr. Larimore's.

Charlie Warwick, Office of the Chief

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OIS NATURAL HISTORY SURVEY

Reports

NATURAL HISTORY SURVEY

Autumn 2002
No. 373

INSIDE

Illinois' Got a Brand-new Bagworm Parasite

The goal of a biological control program is to control a pest while having a minimal effect on nontarget species. Past biological programs based on this principle have proven to be successful and safe alternatives to conventional control practices. There is a growing concern in both scientific and public forums, however, about the impact of introduced biological control agents on nontarget hosts and native natural enemies.

An insect pest against which many natural enemies have been released is the gypsy moth, *Lymantria dispar*. Accidentally introduced into the eastern United States from Europe in 1869, the caterpillar stage of the gypsy moth can cause damage to 500 species of trees and shrubs, most notably oaks and aspen. The parasitic wasp *Pimpla disparis* was first introduced for control of gypsy moth in the 1970s, and continues to be released in some northeastern states. Female *P. disparis* lay their eggs into the pupae of moths. The larval stage of the parasites kills the developing moth and adult wasps eventually emerge from the pupal case.

A female parasitic wasp (*Pimpla disparis*) attempting to parasitize a bagworm inside its bag. **Photo by Michael Jeffords, INHS Office of the Chief**

In hindsight, it is not clear why *P. disparis* was considered a good biological control agent suitable for release. For instance, a parasite being considered for biological control should not have a very broad host range, but *P. disparis* is a generalist and attacks members from at least 13 moth families. Also, parasitism rates of gypsy moth by *P. disparis* are frequently minimal, sometimes as low as 1–2%, which further argues against the release of this species.

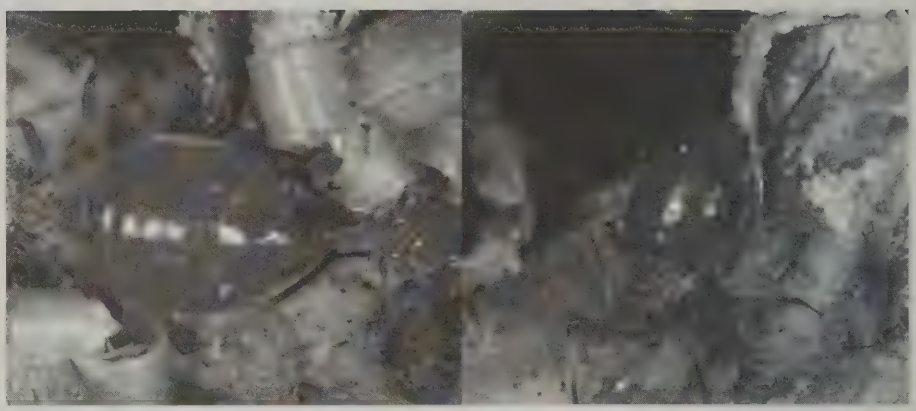
P. disparis has steadily expanded its geographical range well beyond areas where the gypsy moth has been detected. Clearly, *P. disparis* is attacking and surviving in nontarget hosts. The effects of *P. disparis* on nontarget moth populations have not been documented and little is known about the life history of this introduced parasite in Illinois. Although the gypsy moth is not established in central Illinois, *P. disparis* is present and is frequently recovered from the evergreen bagworm, *Thyrid-*

Continued on back page

Aphid Speciation on Pinyon Pines

The process of one species evolving to become two is called speciation. There are a variety of possible causes of speciation, but the best studied involves two populations of a single species that become separated from each other so that they are free to evolve in different directions independently of each other. This separation can happen if individuals migrate across a significant barrier—the sea between islands, over a mountain range, across a desert—and found a new population. However, as long as they do not interbreed, they do not have to be geographically isolated. Speciation can also occur, for instance, if some part of a population begins to feed on a different kind of host, thereby separating them in time and space from the rest of the population on the old host.

Discerning if two insects are different species is generally straightforward, but the more closely related they are, the more they tend to look alike and the harder it becomes to discriminate between them. At some point it becomes impossible to tell definitively if two insects are indeed different species, or just different individuals of the same species; if two populations are in the process of speciating, where (or when) can you draw the line?



Undescribed species closely related to *Cinara terminalis* (Gillette & Palmer) on singleleaf pinyon.

Cinara terminalis (Gillette & Palmer) on two-needle pinyon. Photos (left & right) by Colin Favret, INHS Center for Biodiversity

Two-needle pinyon, *Pinus edulis*, in Great Sand Dunes National Monument, Colorado. Photo by Colin Favret, INHS Center for Biodiversity

As hosts, pinyon pines can isolate aphid populations from each other, and they can isolate them twofold: 1) there are two principal pinyons in the U.S., the singleleaf pinyon and the two-needle pinyon; 2) pinyons grow only in the mountains of the Southwest, and so are separated by vast boundaries of desert between ranges. Fossil evidence suggests that these pinyons moved into the U.S. from Mexico 5,000–9,000 years ago (during the warming and drying following the last ice age), which is just enough time for the aphids that feed on them to begin to speciate.

Pinyon-feeding aphids of the genus *Cinara* were collected from all over the U.S. pinyon range, from southwest Texas to east-central California, and studied to discriminate between the various species. One group of aphid collections has yielded an interesting trichotomy: what had been a single species at one time, thousands of years ago, today is three. Although the three species are superficially identical, they can be differentiated using three pieces of complementary evidence: 1) they feed on three different pinyons (the third are Mexican pinyons that extend into southern Texas and Arizona); 2) one of their genes has three different DNA sequences; 3) statistical analysis of measurements of 15 different aphid parts, 2 of which are the lengths of the third antenna segment and hair on the tibia, clusters the aphids into three distinct anatomical groups. The species on two-needle pinyon has already been officially described, but the other two are new to science and will have to be described and given names. Also, interestingly, the closest living relatives of these three pinyon aphids are species that feed on ponderosa pine, a nonpinyon. Researchers have typically grouped conifer-feeding aphids based on their host, but the fact that the next closest relatives of these pinyon aphids are not themselves pinyon-feeding is cause to reevaluate this practice.

Another group of superficially identical aphids is not as clearly separated. Two distinct DNA sequences correspond to aphids on the two principal pinyon species, but there is some overlap in their anatomy. Some insect species that cannot be differentiated on the basis of anatomy have been named and described solely on genetic evidence, and this may be required here as well. There are several other pinyon-feeding *Cinara* groups at various earlier stages of speciation. Assessing the geographic, genetic, and anatomical divergence among populations of these species will help elucidate the rate at which speciation is occurring.

Of course the easiest thing to do would be to wait several thousand more years and see what has happened to them. Provided the incipient species do not go extinct and remain isolated from each other, they will continue to evolve apart and eventually become distinct species. In the meantime, studying the process will help illuminate a poorly understood area of evolutionary biology.

Colin Favret, Center for Biodiversity

Early 1800s Land Cover in Illinois

A drive along any Interstate in Illinois will take you past fields of neatly planted corn and soybeans, across rivers and railroads flanked by rectangular ponds, and past cities and towns with new tract housing developments and manicured golf courses. While this scene

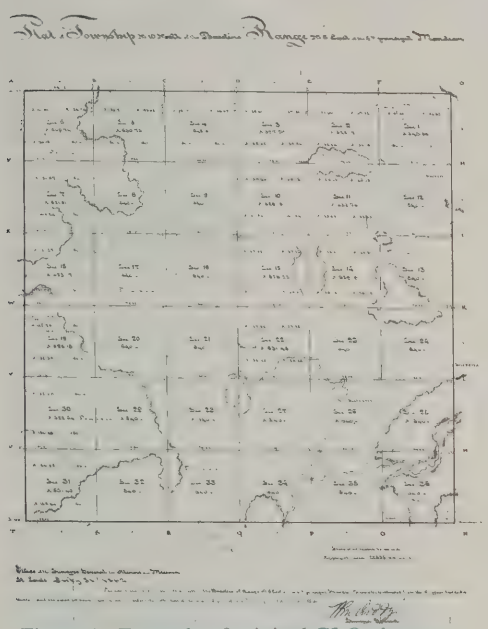


Figure 1. Example of original GLO plat map.

has a beauty of its own, have you ever wondered what the landscape looked like when the first European settlers arrived? We are very fortunate to have a statewide record of what Illinois landscape was like when the first settlers arrived. Illinois was part of a vast tract of land known as the Northwest Territory (the land between the Ohio and Mississippi rivers and extending north around the Great Lakes). The Treaty of Paris ended the Revolutionary War in 1783 and gave the new nation the original 13 colonies plus the Northwest Territory. At that time the United States was independent, but badly in need of money. What better way to raise money then by selling land? However, before land could be sold, it had to be surveyed.

In Illinois, the surveys began in 1804 and were largely completed by 1856. As the surveyors moved across the state, charged with the task of laying out this rectangular grid system, they were required to keep field notebooks. In these notebooks they had to record details about their survey, such as the quality of the landscape, mines, salt licks, watercourses, springs, mill seats, and other "remarkable and permanent things." Once a township was finished, the surveyors were to make a map of the area. These plat maps and field notebooks contain a wealth of information about what the landscape was like before the flood of settlers came into the state. It is these plat maps that the Illinois Natural History Survey used to create a statewide digital dataset of what may be described as early 1800s land cover in Illinois.

Each of the more than 1,700 townships in Illinois has at least one version of the original surveyor's map. Additional redrafted versions are also available for most townships. The redrafted versions were created in the 1850s at the regional General Land Office (GLO) office in St. Louis, Missouri. Cartographers used the original maps in consultation with the field notebooks to create a more complete map of the township. We used these redrafted GLO maps for our land cover map.

Each GLO map was scanned from microfilm onto a laptop computer. We used Adobe Photoshop software and a Canon MS400 microfilm scanner to capture the images, saving them as TIFF files. The images were georectified, or spatially referenced against U.S. Geological Survey Digital Raster Graphic (DRG) images (i.e., scanned USGS 7.5-minute topographic quadrangle maps) by matching the township and section corners on GLO images to the corresponding points on the DRG. This process allowed us to digitized or "trace" the line work on the plat map using Geographic Information System (GIS) software (ESRI Arc/Info).

The scanned, georectified images of each township are now a permanent archive of the GLO maps (Fig. 1). This will allow users to view the original plat maps. The separate digitized version of the maps is a statewide GIS coverage, which can be used on its own or as a layer in GIS analysis (Figs. 2 & 3). The data from records of land cover of Illinois from the early 1800s will provide valuable information in reconstructing a picture of Illinois' natural history and lead to informed decisions concerning habitat restoration.

This two-year effort was partially funded by Illinois Department of Natural

Figure 2. Detailed examples of digitized GLO plat map.

Resources, Office of Realty and Environmental Planning. The poster "Land Cover of Illinois in the Early 1800s" is available through the INHS Distribution Office at a cost of $6.42 (price includes domestic shipping) for single posters. Prices per poster may be cheaper when ordered in bulk. You can order the 26" x 36" color poster by mail from the INHS Distribution Office, Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, Illinois 61820, or by phone at (217) 333-6880 or e-mail at rjohnson@mail.inhs.uiuc.edu. We also hope to distribute a digital version of the data on CDs or via the Internet.

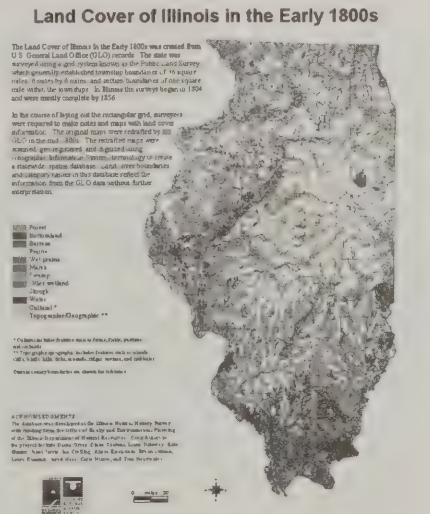


Figure 3. Excerpt of "Land Cover of Illinois in the Early 1800s" poster.

Diane Szafoni, Diane Greer, Liane Suloway, and Janet Jarvis, Center for Wildlife Ecology; Kate Hunter, Center for Biodiversity

Urban Ecology, Part II

In the March-April 2000 issue of this newsletter (No. 362, page 8), I discussed three indicators—depletion, disturbance, and dependence—to characterize the environmental consequences of human activity, which Todd Wildermuth and I applied to an agricultural county in Kansas. The next step is to do the same analysis for an urban area. We already know that a city has high values of all three indicators, especially dependence. The latter has been vividly publicized in the ecological footprint concept.

These impacts of urban life are accepted enough to justify trying to reduce them. Planning (both formal—what professional planners do—and informal) has goals that communities foster and embrace. In particular, the cities of Champaign and Urbana, IL, are updating their comprehensive plans. Rumi Shammin and I are starting a project to determine how the measures in the Champaign-Urbana comprehensive plans stand up against biophysically based indicators of sustainability.

One thing we have learned so far concerns sprawl: sprawl issues have large energy implications. We were skeptical because previous work had shown that at least half of the energy required to support the consumption pattern of an American household results from purchases other than auto fuel or residential heat and light. This fraction is even higher for the more affluent who tend to live in the sprawling suburbs. On the other hand, the standard image of sprawl is of people in bigger houses on larger lots at greater distances from work and cultural areas driving more and bigger vehicles over those longer distances. Therefore, we have taken a closer look.

Our approach fits under the general heading of "energy cost of living." Research over 30 years has produced "energy intensities" for a wide range of consumer goods and services; that is, the energy necessary for the production economy to provide one unit of a good or service for final consumption. Determining the intensities often involves use of economic databases, and the intensities are measured in energy units per dollar. For example, for the entire U.S. economy, intensity ≈ 10,000 Btu (British thermal unit) per dollar. (10,000 Btu is the energy content of about 3/4 lb. coal or 2/3 qt. gasoline.) Intensity varies from commodity to commodity: 9,000 Btu/$ for food at home; 5,400 for housing; 20,000 for public transportation; and 115,000 for auto fuel. These intensities can be combined with details of consumers' expenditure patterns to yield the energy cost of living.

Figure 1a shows the expenditure pattern (in 1999 dollars per year) for an average household. Figure1b shows this market basket converted to its energy requirements. In dollar terms, residential fuel and energy are only 5% of the pie, while in energy terms the fraction has jumped to 44%. Figure 2 shows the energy pies for three different expenditure levels. The direct fraction varies from 56% for the lowest expenditure decile to 33% for the highest.

Of the 15 expenditure categories, 4 can be said to be sprawl-dependent: housing, residential energy, gasoline and motor oil, and auto purchase and

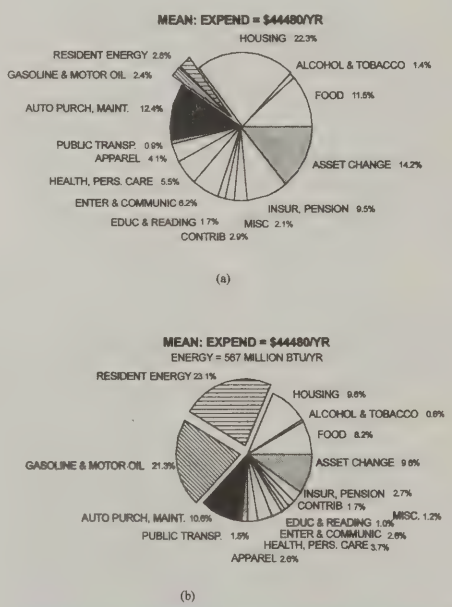


Figure 1. Average U.S. household, 1999: (a) expenditures, (b) energy to produce household's "market basket."

maintenance. Their sum ranges from 72% for the lowest decile to 53% for the highest. Thus over half of the total energy impact comes from these four categories that have most to do with sprawl.

The upshot is that the sprawl-energy connection indeed seems strong even when one is sensitive to the inevitable energy impact of every purchase. Admittedly, this is all very simplified. Among other problems, this analysis assumes that a car that costs twice as much requires twice as much energy to produce, which cannot be exactly right. In addition, one can ask what an "unsprawled" household would do with the money it could save by driving less to and from a smaller, less energy-craving house. If it is spent on fuel for a private airplane, not much energy reduction would result. If it is spent on plane tickets for a trip to Reno, some energy is saved. If it is spent on concert tickets, more energy is saved (the more service-intensive an activity, generally speaking, the less energy per dollar).

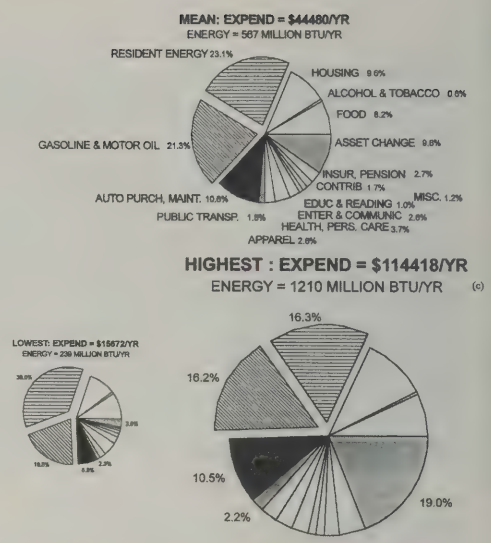


Figure 2. Household energy impacts for three expenditure levels. The areas of the circles are proportional to energy requirements.

This exercise shows that sprawl-related expenditures have significant energy consequences, but also that household energy demand is a consequence of total consumption. Sprawl is usually thought of as a density issue (an intensive quantity), while we see that energy impact has both intensive and extensive aspects. This leads us to ask "Is the problem sprawl (intensive), or is it overall growth (extensive)?" Another way to put this is to compare "efficiency" and overall "scale" in environmental analysis. We will pursue this question in our study of local cities.

Robert A. Herendeen, Center for Aquatic Ecology

Land Use and Quail Population Biology

Local, regional, and national declines in abundances of the Northern Bobwhite have been observed in recent years. Results of the Breeding Bird Survey, for example, reveal for Illinois an estimated 2% *annual* decrease in quail numbers from 1966 to 1996. These local and regional trends suggest the value of taking a critical approach to the study of quail management. Long-term research has established much reliable information about the nesting, brooding, and overwintering requirements of quail; yet, as stated above, in many regions, recent declines have been drastic. A pervasive trend like this is unlikely to occur simply because management has not been sufficiently intensive; the level of expertise among upland game and quail biologists is high and support by the public has traditionally been strong.

Figure 1. A female Northern Bobwhite fitted with a radio collar and leg band ready to be released. Photo provided by Joseph Siegrist

Another pertinent trend is the increasing need to manage state lands with the goal of maximizing or conserving a wide spectrum of biodiversity. In the Midwest, this undertaking often involves ecosystem restoration and the introduction of periodic disturbance by some natural factor such as flooding or fire. Both prairie and savanna/woodland ecosystems are disturbance-mediated ecosystems; neither can persist without this disturbance. Jim Edgar Panther Creek State Fish and Wildlife Area (JEPC) in Cass County, IL, contains both of these endangered ecosystems among many others on a 16,550-acre site. Prescribed fire is being used to restore grasslands, rare hill prairies, and savannas/woodlands. Traditional quail management procedures are also in use on-site such as planting/rotation of appropriate crop species to provide nesting and brood cover in desirable proximity to other cover types. This site presents an excellent opportunity to study quail population biology on a multiple-use area.

Our research is conducted in collaboration with the Illinois Department of Natural Resources and JEPC. From 2000 to date, we have captured and leg banded 148 Northern Bobwhite, 93 of which have been fitted (Fig. 1) with radio collars.

We have found strong trends regarding habitat selection from the radiotelemetry data. Quail strongly prefer warm-season grass fields consisting primarily of warm-season grasses (Fig. 2) including big bluestem (*Andropogon gerardii)*, little bluestem (*Schizachyrium scoparium)*, Indian grass (*Sorghastrum nutans)*, and switch grass (*Panicum virgatum)*. We determined this by comparing the amount of a particular habitat type in an animal's home range with the amount available on-site. Quail also show a weaker preference for areas with some cropland and forested cover. Quail show no preference or avoidance of areas of pasture characterized by a monoculture of tall fescue (*Festuca arundinacea)* and/or smooth brome (*Bromus inermis)*, and cool-season grass fields consisting primarily of red top (*Panicum rigidulum)*, Korean lespedeza (*Lespedeza stipulacea)*, ladino clover (*Trifolium repens)*, and Timothy (*Phleum pratense).*

Figure 2. Yellow coneflower (*Ratibida pinnata*) in full bloom in typical preferred quail habitat characterized by warm-season grass cover. Photo provided by Joseph Siegrist

Through quail telemetry and mark-recovery data, we have determined that our study population (age classes and sexes pooled) has an annual survival rate of approximately 20%. Survival seems to be most strongly affected during the winter months with winter storms having a dramatic impact on mortality. Mortality appears to be primarily due to avian and mammalian predators, with predation by avian species making up the bulk of these.

Our research is ongoing and these results represent just a fraction of our preliminary findings. In the future, we will examine long-term quail habitat selection trends on JEPC. We will contrast that with habitat use data from other suitable habitat islands in west-central Illinois. Using specialized radiotelemetry equipment, we will gather stress and energetics data from the quail during different phases of the year and life cycle, most notably during harsh winter conditions. We will also create a comprehensive demographic model of the Northern Bobwhite in west-central Illinois. Our research will give managers important insight into quail habitat needs, allowing them to improve the efficacy of current management practices.

Joseph Siegrist, UIUC and Jeff Brawn, Center for Wildlife Ecology

Species Spotlight

Mourning Cloak

Susan Post

The first butterfly seen in the spring is usually a mourning cloak, *Nymphalis antiopa*. It is found statewide, and although characteristic of hardwood forests, it can be found in any habitat—forest edges, open woodlands, backyards, and parks. In fact, this species ranges from Europe through temperate Asia to North America, although it is not found in peninsular Florida, southern Louisiana, and south Texas. In England the mourning cloak is known as the camberwell beauty or the grand surprise.

Mourning cloak butterfly (*Nymphalis antiopa*). **Photo from INHS Image Archives**

Mourning cloaks are named for the velvety crepelike appearance of their dark purplish brown wings. Along the wings is a yellow border that fades to near-white in older individuals. The undersides of the wings are striated with dark lines that resemble bark, which allows them to blend in. In flight they are powerful and wary and not easily approached unless distracted by feeding.

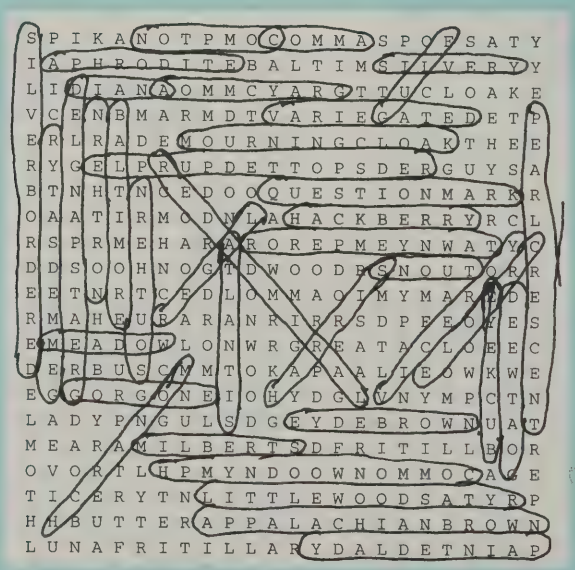
Mourning cloaks belong to the butterfly family Nymphalidae, one of the largest butterfly families. The familiar red admiral, viceroy, and monarch are also members of this group. The butterflies of this family do not have six working legs like other butterflies. Their front legs have atrophied and are now sensory in function. Only the middle and hind legs are used in walking, so in effect these butterflies are quadrupeds.

While most female butterflies will lay a single egg, the mourning cloak lays hers in groupings of up to several hundred. The eggs are pale yellow and laid in a one-layer cluster around a twig. The caterpillars are black and bristly with white speckles and orange prolegs. A full-grown caterpillar will be two inches in length. Once the eggs hatch, the caterpillars stick together. They will line up side by side, heads aligned along the edge of the leaf, and will eat communally. When disturbed the whole aggregation rears up on back legs and shakes menacingly. The larvae feed on willow, elm, hackberry, and cottonwood. The chrysalis varies from whitish tan to bluish black with pink-tipped bumps. It is suspended head down from a small button of silk.

The adults will emerge in June and July and fly until the onset of cold fall weather. Adults visit and feed on overripe fruit, sap flows, and carrion. They will also take nectar from some flowers. The adults will hibernate in hollow logs and tree holes, temporarily becoming active on warm winter days and then going back to winter quarters when the temperatures drop. In late March or early April the adults will become active and soon start searching for a mate, beginning the cycle again. Thus, giving the mourning cloak the distinction of being our longest-lived butterfly.

Teachers Guide to the "Naturalist's Apprentice"

Answers to "Nymphalid Search" from following page.



The Naturalist's Apprentice

Nymphalid Search

Susan Post

The mourning cloak belongs to the largest Illinois family of butterflies, the Nymphalidae. Thirty-eight members of this butterfly family are hidden in the word search diagram below. They may be found horizontally, vertically, and diagonally, and for that extra challenge, some of the names are written backwards. As you labor over the puzzle, remember this: Where else could you find all 38 species living together, using only a pencil instead of a net?

As each species is circled, look it up in a butterfly field guide (my favorite is the *Field Guide to the Butterflies of Illinois* by John Bouseman and James Sternburg). This way, you can become familiar with the butterflies and their habits, haunts, and identification.

Nympalid butterflies hidden in the puzzle include

Aphrodite (fritillary)
Appalachian brown
Atlantis (fritillary)
Baltimore (checkerspot)
Buckeye
Comma
Common wood nymph
Compton (tortoiseshell)
Creole (pearly-eye)
Diana (fritillary)
Eyed brown
Gemmed satyr
Goatweed (butterfly)
Gorgone (checkerspot)
Gray comma
Great spangled (fritillary)
Gulf (fritillary)
Hackberry (butterfly)
Harris (checkerspot)
Little wood satyr
Meadow (fritillary)
Milbert's (tortoiseshell)
Monarch
Mourning cloak
Northern (pearly-eye)
Painted lady
Pearl crescent
Question mark
Red admiral
Red-spotted purple
Regal (fritillary)
Silver-bordered (fritillary)
Silvery (checkerspot)
Snout (butterfly)
Southern (pearly-eye)
Tawny emperor
Variegated (fritillary)
Viceroy

Note: If the word is in parentheses, it is not included in the puzzle.

S P I K A N O T P M O C O M M A S P O F S A T Y
I A P H R O D I T E B A L T I M S I L V E R Y Y
L I D I A N A M M O C Y A R G T T U C L O A K E
V C E N B M A R M O T V A R I E G A T E D E T P
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L U N A F R I T I L L A R Y D A L D E T N I A P

ILLINOIS
NATURAL
HISTORY
SURVEY

607 East Peabody Drive,
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Bagworm Parasite

continued from front page

opteryx ephemeraeformis. The evergreen bagworm is an important native pest that feeds on foliage of arborvitae and juniper, as well as a variety of other woody plant species. In Champaign County (IL) at least three wasp species are known as parasites of bagworms. All three species are members of the Ichneumonidae wasp family. Two of the species, *Itoplectis conquisitor* and *Gambrus ultimus*, are native to the area. The most abundant parasite, however, is the introduced *P. disparis*.

The parasites attacking bagworms go through as many as five generations per year. However, the evergreen bagworm is suitable as a host only when it pupates in autumn. The parasites must therefore utilize alternative hosts at other times of the year. Potential alternate hosts of *P. disparis* may include such introduced pests as the European corn borer and the codling moth in apples. This behavior would actually be deemed a beneficial side effect of the introduction of *P. disparis*. However, if *P. disparis* also attacks native moths that are not considered pests, the secondary effects of this introduction may not be particularly desirable. In addition, we do not know the impact of the exotic *P. disparis* on the established native parasites in central Illinois.

A retrospective examination of the impact of *P. disparis* on the bagworm-natural enemy complex in central Illinois plans to investigate the behavioral and physiological traits that allow competition between an introduced parasite and its native counterparts. The ability of a parasite species to find and utilize alternative hosts determines the abundance of a particular parasite species and its ability to compete with other parasites for the same host. It may be that *P. disparis* is more common in the fall when bagworm pupae are available because it outcompetes native parasites earlier in the season for other potential hosts, or it may be better at utilizing overwintering hosts. Our study may provide valuable information that can help improve the safety and efficacy of biological control programs by minimizing negative effects on nontarget species and native natural enemies.

Marianne Alleyne, Center for Economic Entomology

ILLINOIS NATURAL HISTORY SURVEY

Reports

Winter 2003
No. 374

West Nile Virus in Illinois

INSIDE

A dry ice light trap used to collect mosquitoes in southern Illinois. Photo by Richard Lampman, INHS Center for Economic Entomology

As of December 23, 2002, Illinois had the highest number of human cases (778) of West Nile virus (WNV) in the United States, including 52 deaths. Cook County, which contains about 40% of the population of Illinois, was the hardest hit with 565 human cases and 32 deaths. In some areas of Cook County during August, almost 75% of the pooled batches of *Culex* mosquitoes sent to the Illinois Natural History Survey Medical Entomology Program by collaborators tested positive for WNV. Preliminary bird surveys around Chicago indicated a reduction in the numbers of Crows, Bluejays, raptors (especially owls), and some songbirds. However, transmission of WNV was not limited to Cook County. Since May 2002, a total of 513 birds, 528 mosquito pools, and 1,084 horses in 98 Illinois counties tested positive for the virus. Eastern gray squirrels (from northern and central Illinois), a dog (from central Illinois), and a young zoo-raised wolf (northern Illinois) also tested positive for WNV. Human cases occurred in 48 counties in Illinois by October.

Considering the relatively low clinical case rate of WNV in humans (about 3,900 cases and 241 deaths in the U.S. this year), WNV might be considered of minor public health importance, but there is ample evidence that this arbovirus may have considerable impact on both human and animal health.

First, clinical cases and deaths are just the tip of the epidemic iceberg. Several studies suggest that for every clinical case there are from 30 to 150 infections. Thus, about 16,000 to 117,000 people may have contracted the West Nile virus in Illinois. The statistical extremes of infection, like serious neurological sequelae and death, start to become apparent when increasing numbers of people become infected.

Bob Novak of INHS talks with Macon County Mosquito Abatement District personnel about the introduction of the Asian tiger mosquito to Decatur in tires. Photo by Richard Lampman, INHS Center for Economic Entomology

Second, West Nile virus has become a potential human risk beyond the mosquito route. Transmission may also occur through blood transfusion or organ transplantation from an infected donor. Breast milk samples of infected mothers have also been found to contain WNV, although no infants have contracted encephalitis via this route. However, transplacental infection of an infant by an infected mother was recently reported by the Centers for Disease Control and Prevention. The long-term implications of these nonvector transmission routes are unknown. There are simply too few scientific data at present to answer some important questions about human and animal health, so it is only prudent to be cautious when addressing issues of risk.

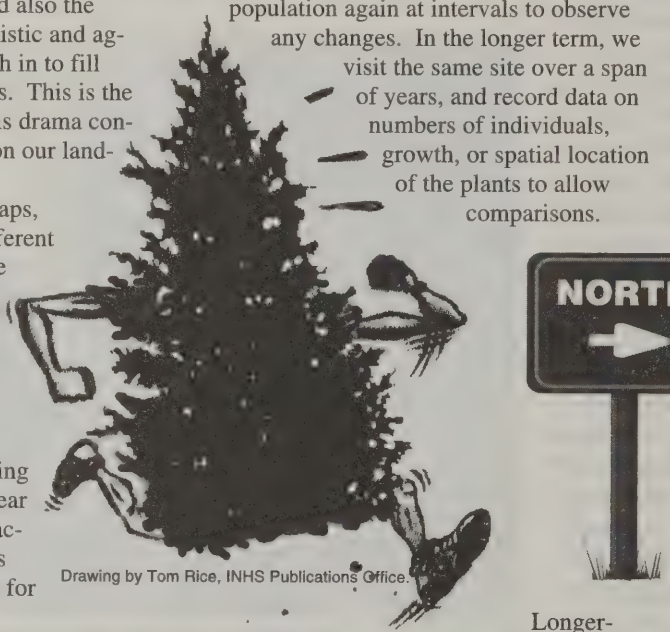
Third, many suggest that WNV will burn out its reservoir

Continued on back page

One Botanist's View of the Landscape

The past two centuries have seen dramatic changes in the environment that have affected the numbers and composition of plants in the Illinois flora. We have already learned of major changes in our flora during the past 20 years alone (see *INHS Reports* no. 372). Major plant communities, such as the prairie, have been almost literally scraped off of the surface of the state to be replaced primarily by agriculture, which takes great pride in reducing the number of plant species in a given area to one. And we *do* need those crops, after all. The work of field botanists in Illinois often involves the location and mapping of what native plants remain, and also the tracking of the opportunistic and aggressive species that rush in to fill the void left by their loss. This is the current situation, and this drama continues to be played out on our landscape.

Field botanists, perhaps, develop a somewhat different view of time to study the longer-term activities of plants. It is clear that plants exhibit a slow pace of growth and movement. Those who observe vertebrates may view plants as less exciting because they do not appear to move or to show the activity that makes animals such interesting subjects for study.



Drawing by Tom Rice, INHS Publications Office.

Plants appear to be permanent features on the landscape, constant and dependable landmarks. Large trees were once used to mark property boundaries in Illinois because of this view. However, field botanists, with a different perspective of time, see plants as active entities that move across the landscape as individual species or as communities, responding to changes in the environment, good or bad, as quickly as they are able. We see plants acting like the animals—as opportunists, advancing to fill new habitats, reaching sources of nutrition, becoming dominant in an area, and then, perhaps, declining and disappearing as the food runs out or when the competition becomes too great. In our mind's eye, we see plants moving south when it gets cold (during periods of glaciation) and north when it gets warm (during interglacial times). We see failures and successes in establishment, almost unbelievable examples of long-distance dispersal, and we see relict pockets of plants disappearing because they cannot change as quickly as the climate or local conditions.

To study these slow changes, field botanists must be patient. For the most part, unless studying animal-plant interactions, we do not sit by a plant and watch it over time (Rip van Winkle excepted). Instead, we make "snapshot" observations, trying to visit a site when the plant is reproductive, and visiting the population again at intervals to observe any changes. In the longer term, we visit the same site over a span of years, and record data on numbers of individuals, growth, or spatial location of the plants to allow comparisons.

Longer-term observations may involve the use of specimens in herbaria (that were collected before the scientist was born) to keep track of the history of a species or population and to determine its relative health in a region. Additional literature and field botanists' notes are also crucial sources of information.

During the growing season, field botanists "uproot" themselves from their desks, herbaria, microscopes, and reports and are on the move tracking down their subjects in the same way that detectives do. The plant detective determines the calender dates when a given plant would be visible and precisely what habitat the sought-after species needs. If the habitat is located, a knowledge of favorite microhabitats and usual associated species is then needed to locate the quarry. We record our observations and prepare voucher specimens that will be used as data by present and future botanists. In this way we record the plants around us and how they change, though those changes may occur at a glacial pace.

The longest-term studies of all are probably those of the palynologists, those botanists who study the sequence and changes in the deposition of pollen over millennia. Pollen is extracted from wetland sediment deposits that can resemble the thin layers of a well-made layer cake. This research has enabled calculations of the migration rates of trees and herbs before, during, and after the ice ages, and some experts have determined, for example, how quickly a particular species of oak moved north as the glaciers melted. The data can inspire a vision of the movement of the forests south to north as if it were a race, with some species moving faster than others, resulting in forest and landscape compositions that can be understood based upon the speed and climate requirements of the "contestants." The reverse can also be visualized—species that cannot move quickly enough being ground underfoot by the advancing glaciers traveling south. Examples abound.

So, what changes on the botanical landscape might we predict for the future? Some climatologists have predicted a major global warming event. If this occurs, perhaps plants needing a cool-climate will move north and disappear from their southern range margins and there will be an increase of southern plants moving into our area. We could probably expect an increase in subtropical and tropical weeds coming into our area during continued human environmental disturbance and climate warming. Perhaps sorghum and cotton will become major Illinois crops as the southern belts shift north. Regrettably, there may be a general major increase in native plant extinctions because of barriers to migration (a general lack of migration corridors) or because of a far-too-rapid warming as the climate changes. Time will tell.

Steve Hill, Center for Biodiversity

Insect-weed Interactions in Snap Bean Crops

Vegetable growers have fewer herbicide options because of increases in costs, regulatory issues, weed resistance to herbicides, and concerns about environmental contamination. Knowledge of weed thresholds (maximum number of weeds the crop can tolerate before yield loss) and the relation between weed emergence time and subsequent crop loss can help growers reduce herbicide use. But, beyond their role as crop competitors, weeds also influence insect pest and beneficial species. By serving as alternative habitat or food sources and affecting crop attractiveness to insects, weeds can affect insect populations differently depending on the specific crop and insect dynamics involved. Knowledge of specific insect-weed interactions can be an important management tool, especially when growers might minimize pest damage by modifying the crop environment.

A crop of snap beans. Photo by John Masiunas, University of Illinois

In research to develop weed economic thresholds in snap (green) beans, we examined the effect of interference from snap beans and two weed species (redroot pigweed and large crabgrass, which are common in this crop) on populations of potato leafhoppers and bean leaf beetles. In the Midwest, snap beans are planted over a four-month period and harvested about two months after planting. As a result, they can draw in insects from surrounding field crops with much larger acreages (e.g., corn, soybeans, alfalfa). Bean leaf beetles and potato leafhoppers are the most damaging insect pests that attack beans in this region. Bean leaf beetle feeding can cause defoliation and pod damage, while potato leafhopper feeding injury ("hopperburn") stunts plants and reduces yield.

In 1998 and 1999, snap bean plots (8 rows wide by 36 meters long) were seeded with pigweed or crabgrass at bean planting (early) or when snap beans had one trifoliate leaf open (late). Weed density averaged two plants per meter; similar plots were kept weed free. Numbers of leafhopper nymphs were determined by direct observation and in sweep-net samples of snap bean foliage, while adult leafhoppers and bean leaf beetles were counted in sweep-net samples twice each season.

Beetle populations, snap bean defoliation, and pod damage were lower in weed-free plots compared to those with early pigweed or crabgrass. Pod damage was greatest in plots with early crabgrass. The greater presence of beetles and their injury in weedy compared to weed-free plots may be a result of habitat differences. The matlike growth of early crabgrass shaded the soil and could have increased soil moisture, making it attractive to egg-laying beetles. Crabgrass and pigweed are not hosts of this insect.

Early crabgrass, in contrast, had a different effect on potato leafhoppers, significantly reducing their numbers by 31 to 34% compared to those in weed-free plots. While pigweed is a host for this insect, the presence of grasses is known to decrease their numbers in legume crops such as alfalfa.

While late weeds did not affect crop growth, early pigweed and crabgrass reduced snap bean biomass in alternate years. Yield was reduced in plots with crabgrass compared to weed-free plots. Most crop measurements were not correlated with leafhopper or beetle populations.

Our study indicates that early weeds, especially crabgrass, in snap bean crops can affect potato leafhoppers and bean leaf beetles differently. Early crabgrass tends to reduce potato leafhopper numbers but increase those of bean leaf beetle. Pigweed had no noticeable effect on leafhoppers, but plots with early pigweed had more beetles. Weed interference had a greater impact on crop yield than did the populations of insect pests (early weeds decreased crop growth and yield even at populations of two weeds per meter). Thus, the effect of near-threshold weed densities on insect pests in snap bean varied depending on the specific insect-weed combination and should be considered in decisions for integrated weed management.

Cathy Eastman, Center for Economic Entomology and Joseph Aguyoh and John Masiunas, University of Illinois

Creel Surveys in Illinois

One of the most useful tools for Illinois fisheries managers is the creel survey. These surveys gather information about angler behavior, including data on angler effort, harvest, and catch composition on inland lakes and Lake Michigan fisheries, providing managers critical long-term data on the numbers of fish being caught and harvested as well as the size of fish caught on Illinois lakes. Creel surveys are more commonly being coupled with complementary research efforts to improve the quality of fishing in Illinois waters.

Nannette Trudeau of the INHS Creel Survey measures a fish caught by Chicago fisherman. Photo by Martha Kneuer, INHS Center for Aquatic Ecology

Jerry Tamborine (right) of INHS Creel Survey collects information from a fisherman at Clinton Lake. Photo by Betty Carroll, INHS Creel Survey

Comprehensive creel survey efforts began in 1985 for the Illinois portion of Lake Michigan and in 1987 on inland lakes in Illinois. Since the inland creel survey's inception, 115 inland lakes have been surveyed, producing more than 500,000 interview records. The Lake Michigan creel survey has produced over 100,000 interview records. The sampling regime and interview methodology have remained constant over the 15 years of both surveys, providing INHS researchers with two powerful long-term datasets.

The goal of a creel survey is to provide the raw materials that managers use to frame management plans and conduct research. An added benefit of these surveys is the public face creel clerks put on the Illinois Department of Natural Resources. Creel clerks interact with the fishing public on a daily basis and therefore are often a primary source of information about angler attitudes and behaviors that may impact the fishery. For management, creel surveys provide information needed to assess if angler impacts are too great to sustain a viable fish population. Creel data also reveal more interesting information about Illinois fisheries than just species and catch composition. For example, anglers and managers alike are interested in the size of fish in a particular body of water. Because anglers often target trophy-sized fish, this information proves valuable to managers who are trying to provide a desirable fishery to anglers around the state.

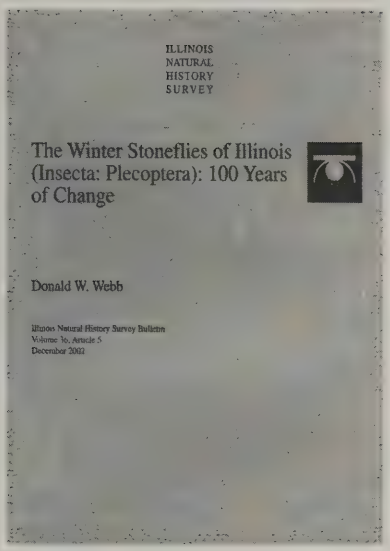
Another key purpose of creel surveys is to supplement research efforts. Several projects, including projects studying bass and bluegill populations, benefit from the added information creel surveys provide. For example, INHS researchers are currently studying the causes of stunting in bluegill populations across 32 lakes in Illinois. Historical creel data collected on many of those lakes during the last 15 years are being used to supplement the research, leading researchers and managers to a better understanding of what causes stunting and how to improve the quality of bluegill fishing.

On Lake Michigan, Illinois creel data are being used to create lakewide estimates of salmon and trout harvest so that mangers can determine optimal stocking rates to support a quality fishery without depleting prey resources or causing more negative impacts on yellow perch. The Lake Michigan creel survey data also are used to evaluate strain performance of salmonids and movement of both salmonids and adult yellow perch. In addition, Lake Michigan creel data are being used to develop catch-age models to predict yellow perch relative population size. This is a critical component to improving harvest management for yellow perch and demonstrates the importance of long-term creel data to enhance fishery management options.

The utility of creel data makes these surveys invaluable to fisheries managers. As stand-alone datasets, they provide critical information on the status of Illinois fisheries. Coupling creel data with standardized sampling and applied research enhances the data's utility and provides a clearer picture of the past, present, and future of Illinois fisheries.

Jeffrey A. Stein, Wayne Brofka, and John Dettmers, Center for Aquatic Ecology

New INHS Publications



Bulletins

Bulletin 36(3): Revision of the Bees of the Genus *Tetraloniella* in the New World (Hymenoptera: Apidae). pp. 67–162. ($10)

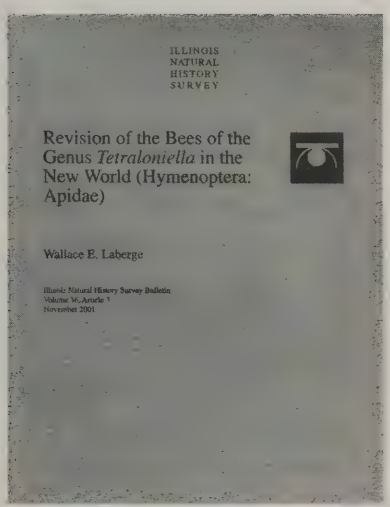
Bulletin 36(4): Natural History of the Wood Frog (*Rana sylvatica*) in the Shawnee National Forest, Southern Illinois. pp. 163–194. ($10)

Bulletin 36(5): The Winter Stoneflies of Illinois (Insecta: Plecoptera): 100 Years of Change. pp. 195–274. ($10)

Special Publications

Special Publication 22: Illinois Landowner's Guide to Amphibian Conservation. 26 pp. ($8)

Special Publication 23: Status and Fucntion of Isolated Wetlands in Illinois. 16 pp. (publication is free if picked up at INHS, otherwise it will be shipped at $1.25 per copy [bulk orders will be pro-rated at book postage rate]).



Field Guides

Manual 9: Field Guide to Butterflies of Illinois. 264 pp. (Hardback, $19.95)

Manual 10: Field Guide to Silkmoths of Illinois. 108 pp. (Hardback, $19.95)

For a complete list of INHS Publications and Education Outreach Materials, please see the INHS Publication Catalog Web site at: http://www.inhs.uiuc.edu/chf/pub/pub-catalog/spring00/index00.html. To order any item from the catalog or to request a free copy of the catalog, contact:

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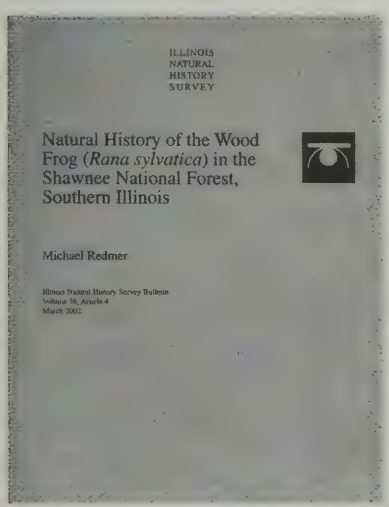
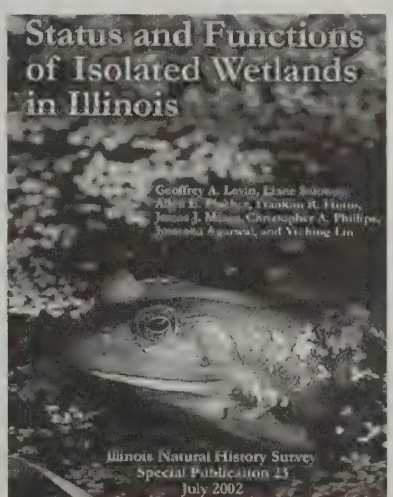
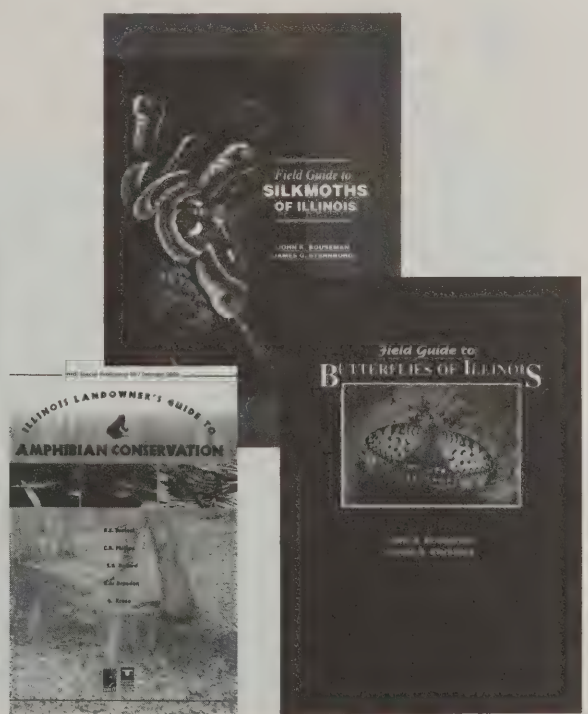






Species Spotlight

Mistletoe

Susan Post

American mistletoe (*Phoradendron leucarpum*). Drawing from INHS Image Archives

Highly prized for Christmas decorations, folklore has it that mistletoe may shed its blessings on those who stand beneath it during the holiday season. Unknown to most people, mistletoe (*Phoradendron leucarpum*) is a native plant of Illinois.

In the ancient forests of Europe, as autumn gave way to winter, the only greenery left was the shrubby growth of mistletoe high in the trees. The fruit of the plant, white berries, was even produced in the winter. In the eyes of the ancient civilizations sharing these same forests, such unique characteristics gave the plant extraordinary powers. It was considered a sacred emblem to the Druids and other pagan peoples throughout Europe, and was recognized with several different names.

Primitive herbalists called it "all-heal" and used it in infusions and teas to promote growth and cure infertility. The Anglos called it "Dung Twig," referring to a rather indelicate natural process by which the plant is spread. The Saxons referred to it more graciously as "Different Twig," recognizing that the plant is indeed something separate from the branches of the tree in which it is found. In present day scientific terminology, the genus name for mistletoe is *Phoradendron*, which is Greek for "thief tree." This rather accurately describes the true nature of mistletoe, a semiparasitic plant that gets most of its nourishment from the trees on which it grows.

Mistletoe has green leaves that provide some energy, but most of its energy needs are taken from its hosts, usually oaks, elms, and poplars. As a semiparasitic plant, mistletoe grows on the branches or trunk of a tree. It sends out roots that penetrate into the tree and take up nutrients. The plant develops a specialized tissue in the shape of a bell called a haustorium, which grows into the host tree and combines with the living tree. Mistletoe survives by starving the host tree, sometimes to its death. For this reason the plant is known by yet another name—vampire plant.

Mistletoe is actually an evergreen shrub with deep green, spoon-shaped leaves so familiar to modern-day holiday decorators. Its dense, leathery leaves mask the small, pale flowers that appear in compact spikes. Male and female flowers are found on different plants. In nature the clusters of jointed stems high within the branches of trees merely resemble poorly constructed bird nests to the untrained eye. Although not actually used by them as nests, birds do play an extremely important role in the life of mistletoe. The waxy white berries are covered with a sticky substance that is poisonous to man, but is relished by birds. New mistletoe plants are often established when seeds are spread to other trees in bird droppings or when birds wipe their beaks on branches and leave a seed or two behind.

In Illinois, wild mistletoe can be found in the southern one-sixth of the state extending northward along the Wabash River to Clark County. Holiday wreaths and festive doorways are other likely sites for its occurrence, but only during the month of December.

Teachers Guide to "The Naturalist's Apprentice"

Terms you should know:

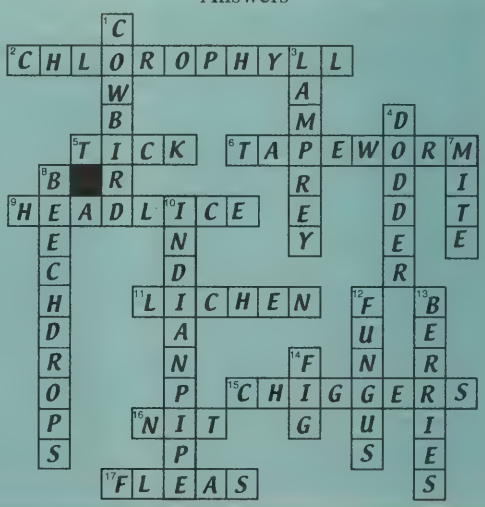
epiphyte—a plant that grows on another plant for support but does not get nutrients from it

host—a plant or an animal on which a parasite lives and feeds, and that gains no benefit from the parasite

parasite—a plant or an animal that will live on or in another organism, the host, and obtain its nutrients from it

saprophyte—a plant that gets its nutrients from dead and decaying organic material

Answers



The Naturalist's Apprentice

Parasitic Plants and Animals Crossword

Carolyn Nixon

Parasitic Plants and Animals Crossword

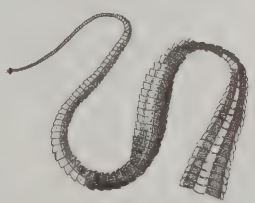
How many of these parasitic and epiphytic plants and animals do you know? You may need to look for help in the library or on the Internet!

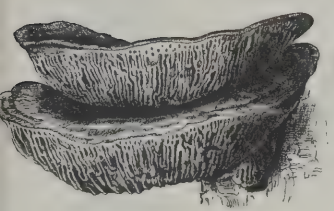
Across

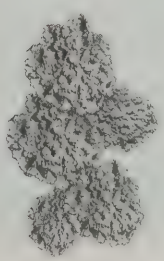
2. Parasitic and saprophytic plants are often lacking this, so they don't appear green like other plants.
5. This blood-sucking parasite can transmit Lyme disease.
6. This long, flat, internal parasite of mammals has many square segments, and often causes the host to lose weight.
9. These tiny insects can really get in your hair!
11. This epiphyte on tree trunks is a good sign, and means there is little air pollution.
15. When these tiny baby mites get under your skin, you'll be scratching for days!
16. The eggs of 9 Across.
17. These circus-performing insects will make your dog scratch.

Down

1. This brown-headed bird is called a brood parasite because it lays its eggs in the nests of other birds.
3. An eel-like fish that is an external parasite on large fish in the Great Lakes is called the sea _____.
4. This orange, stringy plant attacks and feeds on green plants that live in moist areas.
7. Some of these tiny little critters attack baby birds at night, but hide deep in the nest during the day.
8. These little brownish plants feed on the roots of beech trees.
10. This ghostly white saprophyte resembles a Native-American smoking device.
12. Shelf _____ grows on the sides of older trees.
13. Mistletoe is spread around the forest when birds eat these white things.
14. The strangler _____ lives in the rain forest where it grows around tall trees and eventually kills them.







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West Nile Virus

continued from front page

of hosts due to the development of immunity, and rapidly disappear as a major concern. There is simply no scientific evidence to support this on any short-term scale. WNV remains a problem in Suffolk County, New York, where transmission has been recorded for the past four years.

Richard Lampman and Patrick Halbig dip for mosquito larvae in horse manure. Photo by Adam Ringia, INHS Center for Economic Entomology

Antibody rates in avian species tend to vary from year to year and location to location. How can we reasonably predict the future when we don't know the major hosts or the range of geographical variation in transmission dynamics?

Finally, although frequently overlooked, West Nile encephalitis is causing one of the most widespread epizootics in birds and horses in recent U.S. history. The clinical cases of horses with WNV outnumbers human cases by at least threefold in the U.S. (about 14,500 horse cases as of October 19). In addition, Illinois, Indiana, and Ohio are reporting hundreds of sick raptors, most of which are positive for WNV. In 2001, about 5,200 dead Crows and Bluejays were found to have WNV. The mortality rate on other species is unknown, as are the ecological consequences of such a widespread outbreak in birds. Unfortunately, the impact of WNV on a wide range of vertebrates, including humans, appears to broaden as studies continue to learn more about this arbovirus.

The WNV outbreak of 2002 has many parallels with the outbreak of St. Louis encephalitis virus (SLEV) in the mid-1970s, when Illinois had 581 cases in 1975. Therefore, there is historical precedent that suggests east-central states, like Illinois, are somehow "pre-adapted" for arbovirus outbreaks under certain environmental and ecological conditions.

Richard Lampman, Nina Krasavin, Patrick Halbig, Adam Ringia, Marshall van de Wyngaerde, Hyun-Young Koo, and Robert Novak, Center for Economic Entomology

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HISTORY SURVEY

Reports

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Spring 2003
No. 375

INSIDE

INHS Establishes Site for Organic Research

The Illinois Natural History Survey prairie and pond in Champaign will soon have a new neighbor—a Survey field site dedicated to organic research and education. More Americans are choosing organically produced foods at their grocery stores and farmer's markets. Organic farming has become one of the fastest growing segments of U.S. agriculture. Since 1996, U.S. sales of organic products have grown at an annual rate exceeding 20%, topping $9 billion in 2001. This growth is projected to continue, reaching approximately $20 billion by 2005.

Organic farming has become one of the fastest growing segments of U.S. agriculture. Here are a few of the many organic products found at local supermarkets. Photo by John Shaw, INHS Center for Economic Entomology

The National Organic Standards Board (1995) defines *organic* as "an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony." Organic production systems seek to support beneficial organisms, nutrient cycling, soil tilth, and nitrogen fixation through greater crop diversity and enhanced soil biological activity. These systems rely on practices such as cultural and biological pest management, exclude the use of synthetic chemicals and genetically modified organisms in crops, and prohibit the use of antibiotics and hormones in livestock. Through the Organic Foods Production Act (1990), the U.S. Congress established national standards for organic commodities. Implementation of the organic labeling provisions took effect in October 2002.

Very little research has been done on organic systems, and organic producers have criticized federal and state departments of agriculture as well as land-grant universities for failing to provide programs to meet their needs. In a comprehensive survey of U.S. organic producers, respondents identified 1) weed management, 2) relationships between fertility management and crop health, pest and disease resistance, 3) relationships between organic management and nutritional value, 4) soil biology, 5) crop rotations, and 6) cover cropping as their top research priorities. They also expressed strong interest in whole farm planning/design, ecosystem integration, and permaculture.

To address these priorities, Survey scientists have joined

Continued on back page

Cave Amphipod Respiration in Southwestern Illinois

The cave environment presents unique challenges to the organisms that live there. The constant and total darkness away from the cave entrance makes eyes and body coloration superfluous and many cave dwellers have no, or greatly reduced, eyes and are pale in coloration. To find each other and food, they have evolved other sensory or chemosensory structures, such as long antennae in crickets and amphipods and well-developed lateral lines in fish. The lack of light also greatly reduces the amount of food available in caves compared to surface environments. To overcome this obstacle, cave organisms generally have a lower metabolism than their surface kin. Thus, the little food that is available, often washed in from the surface, can fuel metabolic needs for a long period of time and excludes surface species that have higher metabolic demands. Other characteristics, such as longer life span, lower reproductive rate, older age at maturity and first reproduction are also associated with a low metabolism and are common among cave-adapted organisms. These characteristics make cave communities and species susceptible to invasion and extirpation by surface organisms in the face of above-normal nutrient availability, such as those associated with inadequate septic systems and agricultural practices.

The karst landscape of the Salem Plateau of Monroe and St. Clair counties contains numerous caves with streams, some of which are home to the federally endangered Illinois cave amphipod, *Gammarus acherondytes*, a true cave-adapted species, or trogolobite. Because of the nature of the karst geology, surface runoff is directed into the caves almost directly through sinkholes with little prior filtration or breakdown of wastes or chemicals. The high rate of urbanization and agricultural activity on the surface has led to higher than normal nutrient and bacterial concentrations in cave streams (*INHS Reports* 361:2). As a result, *Gammarus troglophilus*, an amphipod species associated with surface springs but also capable of living in cave streams, may be outcompeting and displacing *G. acherondytes* in the caves.

We are conducting a series of respiration experiments to determine if metabolic rates differ between the two amphipod species. We are interested in respiration rates for several reasons. First, the results will help us to better understand the respiratory requirements of the amphipods. Results may indicate a minimum dissolved oxygen concentration in the water for survival, similar to the requirements known for many fish species. Second, results will indicate whether or not a difference in metabolic rates exists, perhaps favoring *G. troglophilus* with a competitive advantage at above-normal food conditions.

Frank Wilhelm (front) of Southern Illinois University and JoAnn Jacoby of INHS search Illinois Caverns for amphipods. Photo by Steven Taylor, INHS Center for Biodiversity

To measure the oxygen consumption of amphipods, we assembled small-scale respirometers with micro-tipped oxygen electrodes that are attached to individuals. Such small electrodes consume very little oxygen themselves and are sensitive to small changes in ambient concentrations, making them ideal for our purposes. In the summer of 2002, we collected *G. acherondytes* and *G. troglophilus* from Illinois Caverns. To measure the oxygen consumption, individuals were placed in respiration chambers filled with filtered cave water and four small aquarium rocks. The chambers were then sealed, the oxygen probe inserted, and oxygen consumption measured for four hours.

More than 50 respiration runs have been completed, approximately half with each amphipod species. As expected, large amphipods consumed more oxygen than small individuals ($\mu g\ O_2 \bullet animal^{-1}$ vs body mass). However, expressed on a per unit weight basis ($\mu g\ O_2 \bullet mg\ tissue^{-1}$ vs body weight), small individuals had a higher metabolic rate, an expected relation based on the higher surface to volume ratio of small compared to large individuals. Even though large *G. troglophilus* consumed slightly more oxygen than *G. acherondytes*, a comparison between the two species has not revealed any statistical difference in metabolic rates. These respiratory rates may have been influenced by atypically low concentrations of bacteria in the groundwater, caused by the drought conditions in the summer of 2002. We are continuing the respiration experiments in February and May to account for possible seasonal influences.

In addition to learning about respiration in these amphipods, our work allows us to examine other questions. For example, very little is known about the life histories of these organisms, and by measuring the animals prior to release, we are able to collect size class data. In the laboratory we are also obtaining information about food consumption rates and survivorship.

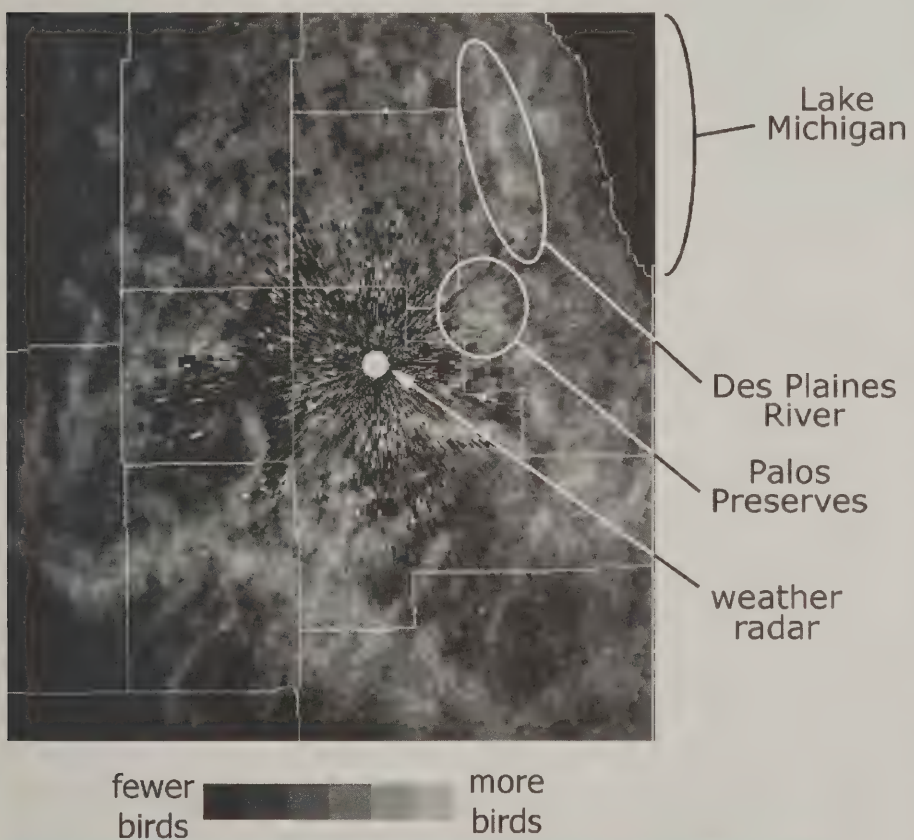
Some populations of the Illinois cave amphipod have apparently disappeared completely, or have exhibited abrupt, catastrophic declines. If we can identify factors important to maintaining healthy populations of the cave amphipods, it may be possible to affect changes (e.g., land-use practices) that help the species, the groundwater community, and water quality in general.

Michael P. Venarsky and Frank M. Wilhelm, Southern Illinois University; Steven J. Taylor, Center for Biodiversity

Weather Radars Reveal Bird Migration Patterns

A songbird arrives over central Illinois after a long nocturnal spring migratory flight. As morning twilight appears on the eastern horizon, the bird seeks the familiarity of forested habitat in which to rest and refuel before continuing north. But below, a sea of agriculture stretches to the horizon, dotted only by an occasional wooded patch. Exhausted after a long flight, the bird makes for a nearby patch. Or does it?

Although in reality we can only speculate about what goes on in a birds' head during migration, one wonders how migrating birds respond when finding themselves in inhospitable landscapes and how these responses shape their distribution in the landscape between migratory flights.



Radar captured this snapshot of the onset of migration throughout northeastern Illinois. Birds departing wooded habitats are revealed as distinct regions of strong echo.

These are tough questions to answer about animals that migrate up to a mile high in the atmosphere and largely at night. Biologists usually cannot rely on simple means such as direct visual observation to unravel the mysteries of bird migration. Fortunately the same national system of weather radars that warns the public of tornadoes and severe thunderstorms allows biologists to observe the movements of millions of birds during migration.

Spring and fall migration begins at night about an hour after local sunset. Radar shows this onset of migration as a sudden eruption of radar echoes as millions of birds depart habitats across the landscape. The radar tells us where birds take off and we can identify which kinds of habitats supported high densities of birds during stopovers. For example, considerably stronger echoes are associated with forest habitat than the agricultural habitat that dominates much of Illinois. Radar even reveals birds departing specific forest patches, especially where such patches are islands of habitat in a sea of agriculture. In this way, radar can identify which habitats support exceptionally large numbers of birds during migratory stopover, valuable information for migratory bird conservation.

Radar shows little evidence that migrating songbirds organize themselves into traditional flyways or corridors. Rather, they form a vast migratory layer in the lower mile of the atmosphere during much of the night. They pass over Illinois in broad fronts, their behavior in the air probably determined more by wind and weather than any potential hazards posed by the landscapes below. Come morning, songbirds are as likely to find themselves over the plentiful forests of the Shawnee as they are the agricultural landscapes of central Illinois or the featureless expanse of Lake Michigan.

Songbirds over Lake Michigan at dawn must make landfall. After rising in altitude, presumably for a better vantage in search of nearest land, radar shows that a bird over Lake Michigan at dawn will engage in one of two behaviors depending on its distance from shore. Birds within 30 km (19 miles) will reorient or change direction toward the nearest shore. Such behavior may result, at least temporarily, in large numbers of birds arriving in coastal habitats before dispersing inland. Birds greater than 30 km from shore will continue flight along an unaltered route, relying on energy reserves to carry them to an unseen shore.

Although central Illinois poses none of the immediate risks of being over water at dawn, it is nonetheless a challenging landscape for a forest dwelling songbird seeking stopover habitat after a long nocturnal flight. Even before human settlement, forested habitat was never common in this area once dominated by tallgrass prairie. Today less than 5% of east-central Illinois is forested, down considerably from presettlement levels. As a result, migrants pack themselves into available forest habitat at more than twice the density they do in more forested places. Food in these forest patches is scarce, and birds struggle to gain mass in preparation for the next migratory push. However, because these scattered forest patches offer migratory songbirds the only food (although meager) and protection, their scarcity in the agricultural landscape is an argument for their protection.

We wish to thank Chicago Wilderness for supporting this research.

Robb Diehl, University of Illinois; Ron Larkin, Center for Wildlife Ecology

Largemouth Bass Virus: An Emerging Fish Pathogen

Nothing draws attention to problems with wild fish populations like a fish kill. In 1995, a kill of approximately 1,000 largemouth bass occurred in the Santee Cooper Reservoir of South Carolina, sparking a great deal of public and scientific concern. The usual suspects of heat stress, toxic substances, and known pathogens were suggested, but none were found to be involved. Investigations led instead (and surprisingly) to the discovery of a new virus, Largemouth Bass Virus (LMBV). Because no viruses had previously been associated with either systemic infection or epidemic mortality in wild largemouth bass, this finding generated considerable concern among fisheries biologists and anglers.

LMBV has since been classified as an iridovirus (family *Iridoviridae*), a diverse family of large DNA viruses that infect reptiles, amphibians, fish, insects, and a variety of other invertebrates. It is closely related genetically to viruses of ornamental aquarium fish. This close relationship suggests that LMBV may have originated from the introduction of an exotic (Southeast Asian) pathogen into North American waters.

LMBV has been documented only in the United States. Since its discovery in 1995, and through 2003, it has been found in 17 states (see map on facing page). The occurrence of the first LMBV-associated fish kills in the Southeast seemed to imply a westward and northward expansion from a southeastern epicenter. Fisheries biologists, however, are continually discovering LMBV in new locations, and its origins within the U.S. are still unclear. Interestingly, a virus genetically identical to LMBV was recovered from frozen bass sampled in 1991 from Lake Weir in Florida, four years before the South Carolina outbreak. LMBV has probably been around for some time. Because not all states have surveyed for LMBV, the geographic distribution of the virus is almost certainly more extensive than that shown in the map.

LMBV has been found both in populations of bass that have experienced documented fish kills, and in apparently healthy populations as well. Affected fish float to the surface and lose equilibrium prior to death, but show no external lesions. Hyperemia (increased blood flow, leading to darkened coloration) is occasionally seen, but is not consistently associated with infection. Internally, many (but not all) fish have inflamed swim bladders, a condition known as pneumocystitis. Neither the mechanism by which LMBV kills fish, nor its mode of transmission is known.

A central database for LMBV is being maintained by the U.S. Fish and Wildlife Service Warm Springs Regional Fisheries Center, in addition to the recently released National Wild Fish Health Survey Database. Preliminary results of these surveys indicate that the virus is highly prevalent both as a proportion of total samples tested within states (between 7% and 49%) and as a proportion of sites tested (between 22% and 75% of sites in states in which at least 10 sites were tested). Within lakes, the prevalence of LMBV appears to vary considerably from year to year, and may decline after a fish kill. Lakes positive in a given year appear to remain so, but conversions from negative to positive status have been documented.The emerging pattern is that LMBV tends to strike in summer months, possibly precipitated by stressors such as elevated temperature, low oxygen, and angling. LMBV-associated fish kills have not been reported to occur in lakes repeatedly sampled in consecutive years, but longitudinal observation has been limited to date. Although, lakes that do experience fish kills also suffer observable declines in angling catch-per-unit-effort and possibly in the proportion of large fish caught, these effects seem to be transient. LMBV, therefore, appears to be as variable over time as it is across space.

Whenever new pathogens are discovered, debate inevitably ensues as to whether the pathogen is truly new or whether surveillance and detection methods have simply improved. LMBV is no exception. LMBV could be a recently introduced exotic pathogen, or it might have existed unnoticed in the U.S. for years. Nevertheless, LMBV is an emerging pathogen in the sense that its political and scientific visibility is increasing.

One of the most vexing questions about LMBV, recognized by scientists and nonscientists alike, is why some populations of infected bass experience fish kills while others, also infected, remain clinically normal. Different populations of largemouth bass may possess different levels of resistance or susceptibility to LMBV. Host immunity may be important, as well as the genetic composition of different bass populations. Innate genetic immunity to the virus, as well as varying levels of inbreeding and outbreeding depression, could be involved. It is also possible that there are multiple strains of LMBV, each with varying degrees of virulence. Finally, environmental factors could interact with either the host or the pathogen (or both) to precipitate disease.

Unfortunately, too little is known about the pathogenesis, epidemiology, and natural history of LMBV to predict its future impact. Even if the virus does not kill fish outright, it could alter their behavior or physiology in ways that decrease a population's sustainability or its utility to recreational anglers. Given this fact that LMBV does not appear to be present everywhere throughout its range, it is best considered as a pathogen in the process of emerging. Its consequences have yet to be played out in full.

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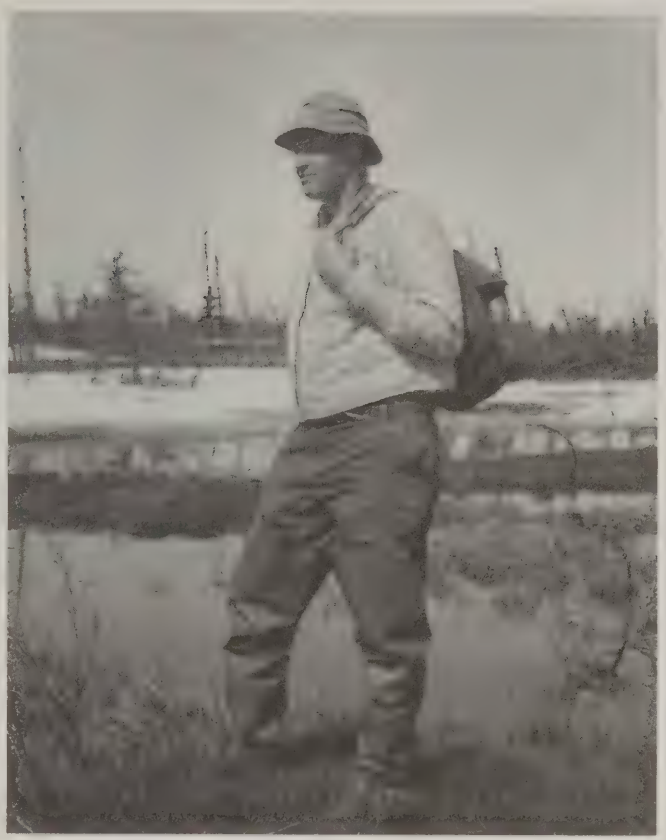
In Memoriam

Harold C. Hanson
1917–2003



Harold C. Hanson, retired Professional Scientist with the Illinois Natural History Survey, passed away March 17, 2003. Dr. Hanson graduated in 1940 with a B.S. degree from Luther College, received an M.Sc. degree from the University of Wisconsin in 1943, and earned his Ph.D. from the University of Illinois in 1958. No funeral or memorial service are planned.

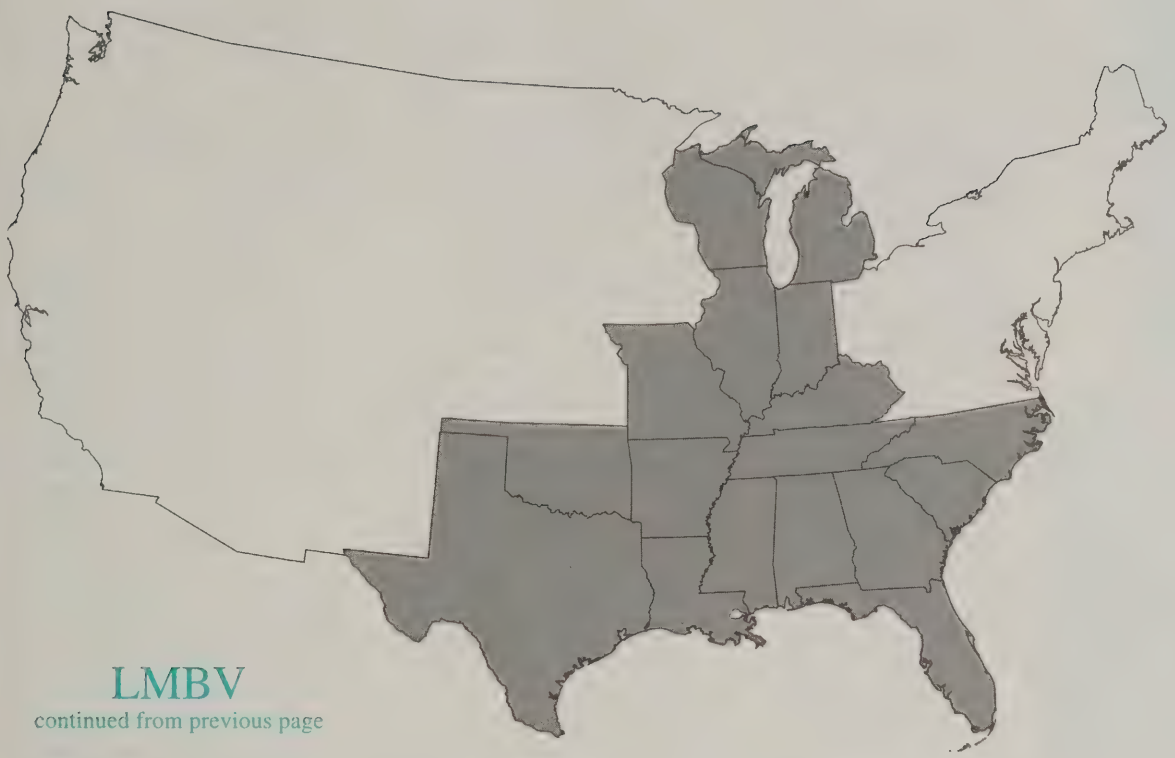
Harold Hanson was the author or coauthor of more than 40 scientific publications, including studies of arctic birds and mammals, cottontail rabbits, Wood Ducks, diseases and parasites of ducks and geese, voles, Sharp-tailed Grouse, Canada Geese, and other topics. Several of his research projects reported results that were new directions for research or landmark works. These included techniques for determination of age and sex in birds, artificial propagation of captive waterfowl, bioenergetics of reproduction in birds, Mourning Dove ecology, use of feather minerals as biological tracers for determination of breeding and molting grounds of waterfowl, the importance of mineral licks to North American ungulates, and the identification of various races of Canada Geese. It was this last topic that consumed Dr. Hanson's later years as he worked on a multi-volume treatise *The White-cheeked Geese*. Dr. Hanson won The Wildlife Society's Terrestrial Publication Award in 1967 for his book, *Giant Canada Goose*, and the same award in 1978 for *The Biogeochemistry of Blue, Snow, and Ross' Geese*.

Dr. Hanson spent a number of field seasons in the Canadian Arctic where he became familiar with prominent Arctic explorers in the first half of the 20th century. He became a defacto expert in the diversity of land forms that compose the Canadian Arctic and spent many years studying the correlations among geology, climate, and Canada Goose evolution.

Dr. Hanson was an excellent photographer who enjoyed not only taking pictures but also enlarging and printing them in his darkroom. He photographed Olympic ski jumpers as a hobby. Recently he became excited by computers and digital imaging. He personally scanned hundreds of his photographs for use in his compendium *The White-cheeked Geese*.

A conversation with Dr. Hanson was seldom a short or simple affair. While his mind remained sharply focused on any topic that currently obsessed him, it also ranged widely on multiple tangents related to his focus. A question about goose migration could elicit comments from Dr. Hanson on flyways, goose evolution, evolution theory, the history of scientific thought, field experiences in the Arctic, customs of the Cree Indians, and personal scuttlebutt about other researchers and academicians whom Dr. Hanson had encountered in his long career. Coupled with his wry, and often scathing wit, every encounter with Harold Hanson was a feast of fact, fun, and fascination.

The world has lost a colorful and truly unique individual with Dr. Hanson's passing.



LMBV

continued from previous page

Perhaps the greatest concern is warranted not for the specific effects of LMBV, but rather for what the presence of this new pathogen may signify. Wildlife diseases appear to be emerging at an accelerated rate across the world. The growing consensus is that anthropogenic changes to the environment underlie this phenomenon. The pressures levied on wildlife by humans may account for the recent emergence of so many novel pathogens. If so, then LMBV may be an early indicator of a coming wave of health-related problems in which the sustainability of our wild fisheries declines by our own hand.

Acknowledgments

The ideas outlined in this article in large part reflect those of the participants in the 2001 and 2002 workshops on LMBV, organized by B. Shupp and the Bass Anglers Sportsman Society. Further discussions with J. Grizzle, R. Bakal, J. Plumb, A. Noyes, M. Conlin, J. Koppelman, S. Shults, and L. Willis were also highly informative. R. Bakal and J. Plumb provided helpful comments on the manuscript. Funding to support LMBV-associated research was generously granted by the Illinois Council on Food and Agricultural Research and by the Conservation Medicine Center of Chicago.

Tony L. Goldberg, Kate Inendino, and Emily Grant, University of Illinois; David P. Philipp, Center for Aquatic Ecology

Important Note to Subscribers

We are updating our mailing distribution list to *Illinois Natural History Survey Reports*. Therefore, we need to hear from all subscribers who would like to continue to receive *INHS Reports* in the mail. To assist our subscribers in this project, we will be sending each address currently on the mailing list a card through the mail in the near future. The card will request those who wish to continue receiving *INHS Reports* in the mail to fill out the card and return it the Illinois Natural History Survey by May 31. Postage for these reply cards is prepaid, so there will be no expense for those who choose to reply. However, only those subscribers returning the reply cards will be retained in the mailing database.We will assume that subscribers who do not return their cards either no longer wish to receive our newsletter via the mail or that their addresses are no longer valid.

Of course, whether they remain on the mailing list or not, readers of *INHS Reports* always have the option of accessing it on the Web at URL: http://www.inhs.uiuc.edu/chf/pub/surveyreports/sr-index.html

Species Spotlight

Striped Skunk

Susan Post

Imagine a mammal that runs slowly, has little endurance, and eyesight so poor that it has trouble picking out stationary objects over six yards away.

Striped skunk (*Mephitis mephitis*).
Photo from INHS Image Archives

How would it avoid becoming "easy" prey? If that mammal is the striped skunk, it has a potent chemical defense system that assures it will not be bothered.

The striped skunk, *Mephitis mephitis*, is found only in North America. Its range extends from central Canada to northern Mexico. In Illinois it is common and found throughout the state. While skunks use a wide variety of habitats, they prefer forest borders, brushy areas, and open grassy fields broken by wooded ravines and rock formations. Skunks can dig their own dens, but prefer to use those excavated by other animals such as woodchucks. Den sites include stumps, caves, rock piles, old buildings, junk piles, woodpiles, or dry drainage tiles.

Skunks are about the size of a domestic cat. They have triangular heads and are boldly marked. A skunk is glossy black except for a narrow white stripe on its nose and forehead and a wide white stripe on its back that divides into two stripes that continue part way over the back. The tail is long (6–15 inches) and fluffy. The total length of the animal, including tail, is 20–30 inches.

Skunks are generally solitary, although females will sometimes winter together in underground dens. In early spring males and females mate and the female will give birth in early May to four to eight blind, hairless kittens. At six weeks of age the young skunks will follow their mother single file into the woods to forage for food. They take the same route every night. The mothers are protective of the kittens during the early weeks and assume all training and feeding responsibilities. By the age of 10 months the juvenile skunks are full-grown.

A small, conical hole in a grassy area of lawn that has no dirt around it is a sign that skunks have been digging for grubs. Skunks will eat both plant and animal foods, but insects, such as bees, grasshoppers, and grubs, are preferred foods. They will also eat mice, young rabbits, voles, birds and bird eggs, corn, cherries, and even carrion (dead animals). During the fall skunks build a layer of fat. This layer of fat will provide energy for them during the winter when they spend most of their time sleeping in dens. Skunks are not true hibernators, as they will venture out of their dens if temperatures are above freezing.

Its scientific name comes from the Latin for "a poisonous vapor coming from the ground." The common name skunk is thought to come from the Abnaki Native American name segonky, meaning "he who urinates." Another common name is polecat, which is from an old French word meaning "fowl" or "hen," since skunks often raid the farm henhouse.

While several Illinois mammals have scent glands, the gland development is greatest in the skunk. The skunk's "poisonous vapor" is an amber, oily liquid stored in musk glands located at the base of the tail. The glands open to the outside through small nipples, which are hidden when the tail is down. The skunk has control over the glands, so the stream may be sprayed as a fine to a powerful stream of liquid beads. The chemical name of the musk is butylmercaptan. The odor molecules of this fluid are powerful enough to be detected through glass, plastic, and metal.

A skunk will give warnings before using its odor defense. These include arching its back, shaking its head, raising its tail, and stamping its feet. When these fail the skunk turns around with tail raised and takes aim. This defense is fairly successful except against domestic dogs, coyotes, badgers, and great horned owls, which kill a few skunks. Unfortunately, this defense does not work on vehicles or farm machinery, which are major sources of mortality.

Cherokee Native Americans believed that the scent of the skunk would keep away contagious diseases. A "scent bag" containing the odor was hung over the doorway and a small hole was pierced though the bag so the scent would permeate the room. If an epidemic was particularly bad, the entire body of the skunk was hung up, the meat cooked and eaten, and skunk oil rubbed over the skin. While the odor of the skunk may not contain natural chemicals that can combat contagious disease, the odor probably discouraged visits from those who may have been infected and helped stop the spread of the disease, making the stench effective in its own way.

Teachers Guide to "The Naturalist's Apprentice"

Notes for Teachers and Parents

Explain that if animals make errors in choosing a mate, they will not be able to reproduce. This would be a dead end. Injury or death may result if the wrong mate is chosen.

Closely related species occasionally produce hybrids (a cross of two different species). Include some scents that are similar (orange and tangerine slices, for example) and determine what percent of the population would make mistakes when picking a mate. Explain that most hybrids either die or are sterile (unable to reproduce themselves), so this would likely be a dead end. A common example of a hybrid is a mule, which is a cross between a horse and a donkey.

Classes can be divided into six groups, each representing one species, but each student must sniff and record his or her results individually.

The Naturalist's Apprentice

Animals Make Scents

Carolyn Nixon and Michael Jeffords

Animals Make Scents—The Pheromone Game

Scents are important to animals in more ways than just defense. Different scents may be used to mark territory or attract a mate. Scents produced by an animal to give a chemical signal to other animals are called pheromones. Pheromones help many animals to find mates. To demonstrate how pheromones work, let's play the Pheromone Game.

MATERIALS NEEDED

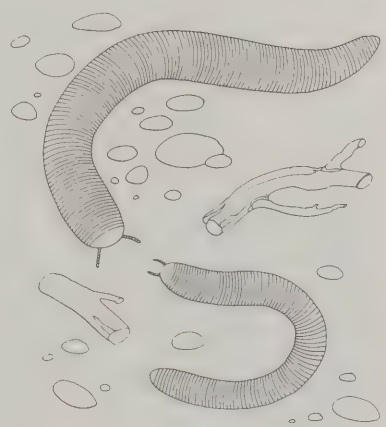
- 18 baby food jars with lids
- aluminum foil or black paint
- a punch or a sturdy nail and a hammer to punch holes
- 3 each of 6 different common food items with distinct odors: (examples include garlic, slices of lemon or orange, chocolate, peanut butter, cotton ball soaked with coffee or vanilla extract)

PROCEDURE

1. Cover each jar with aluminum foil or paint the jars black. Punch five or six holes into each jar lid. Number the jars consecutively, 1 through 18. Place a sample of one of the six items with distinct odors into each of the jars; replace the lids and number the jars. There should be three jars of each food item. Record which items are in which jars on a sheet of paper. Randomly place the jars about the room.

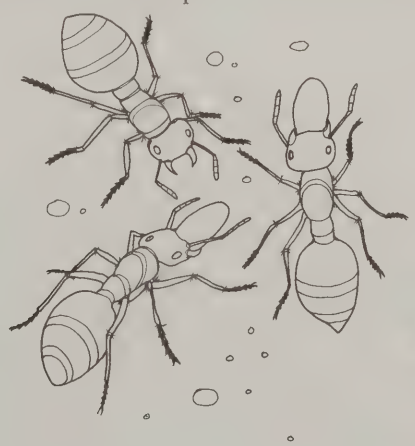
2. Write the names of each of the six items on separate slips of paper, one for each player.

3. This is a silent exercise and no talking or other communication will be allowed. Ask each player to list the numbers from 1 through 18 on a sheet of paper and to carry this list and a pencil throughout the exercise. Show each player one of the six slips of paper; this is the special odor for which they are to search; no other odor is of interest to them. Players then sniff the contents of each jar and place an X opposite the numbers on their lists that correspond to the numbers on the jars that they think contain the special item for which they are searching.



4. After the sniffing has concluded, reveal the contents of each numbered jar so that players can check the accuracy of their noses. An accurate nose should have detected the same scent in three different jars.

If players successfully identified the correct scents, they would have been able to reproduce. If they made mistakes, they would have failed in those attempts.



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Organic Research

continued from front page

colleagues at the University of Illinois on an Organic Task Force to provide greater focus on organic issues and to facilitate development of multi-disciplinary, cross-institutional research and education projects pertinent to organic systems. As part of its commitment, the Survey recently designated six acres at its Windsor Road site for long-term research on organic production systems. Survey and university scientists have teamed up to initiate a research program for this site, which will be developed following organic certification guidelines. Participants at present include specialists in vegetable entomology, crop protection, soil biology, weed science, composting, and soil organic matter. The initial research will focus on organic transition. Land must be free of synthetic chemicals for three years before crops grown there can be certified as organic. This period—when growers are transitioning from conventional practices that relied on synthetic chemical inputs for fertility and pest management—presents great challenges for organic producers but also great opportunities for exploration of the complex changes in the soil food web that occur during the transition. Research at the long-term site will compare organic systems differing in use of tillage, cover crops, and soil amendments to manage weeds and soil fertility, with more specific experiments conducted within each system. Additional acreage nearby is available for short-term projects pertinent to organic production. To ensure the relevance of the research to Illinois producers, the research team is seeking input from experienced organic growers to serve as an advisory panel to evaluate potential organic systems and specific experiments within each system. Results from this research, while emphasizing improvement of organic systems, will also have value for sustainable and conventional farm systems that are seeking ways of reducing inputs.

John Shaw, Cathy Eastman, and Ed Zaborski, Center for Economic Entomology; Michelle Wander, John Masiunas, and Dan Anderson, University of Illinois; and Leslie Cooperband, University of Wisconsin

Illinois Natural History Survey Reports is published quarterly by the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the Illinois Department of Natural Resources.

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Reports

Summer 2003
No. 376

INSIDE

The Age of the Turkey

Depending on your perspective, it is a good time to be alive if you are a turkey, turkey hunter, or a turkey biologist in Illinois. With a population estimate of around 135,000 birds statewide, there are probably more turkeys roaming the woodlands of Illinois now than at any time prior to European settlement. Spring hunting is permitted in 96 counties, fall hunting is becoming increasingly popular, and the demand for hunting opportunities continues to increase in Illinois. The National Wild Turkey Federation (NWTF), a conservation organization dedicated to wild turkeys, boasts 450,000 members nationally, and Illinois is its top state for number of local chapters (110) and members (>30,000). Through banquets and other fundraising efforts, NWTF has raised over $168 million since 1985 for the conservation of turkeys and their habitat.

A pair of Eastern Wild Turkeys in a forest near Monticello, IL. Photo by Charlie Warwick, INHS Office of the Chief

Turkeys congregate at a dam site in Hardin County. Photo by Patrick Hubert, INHS Center for Wildlife Ecology

Despite the turkey's popularity and support for management programs, turkey biologists face new challenges resulting from the adaptability of the species. These include conflicts in urban areas, concerns over crop depredation, and management of turkeys in novel landscapes. Central Illinois, dominated by intensive agriculture, is one example of a novel landscape. Research in the Illinois Natural History Survey Center for Wildlife Ecology examined the ecology of turkeys in agricultural landscapes of Cass and Clark counties using radiotelemetry. Overall we found that turkeys in central Illinois have similar population characteristics as those in other parts of the Midwest in what is considered ideal habitat. During our study, approximately half the hens survived each year and the nesting season was the most dangerous time for hens. Coyotes, foxes, and roaming dogs were the primary predators of adult hens. Winter mortality is uncommon in Illinois but several mortalities during the winter of 1999–2000 were attributed to disease and parasites and point to a need for further research.

Winter severity also affects the number of hens that attempt to nest during the following year. Nearly all hens nest following mild winters while fewer hens nest after severe winters. Turkeys in central Illinois nest in a variety of habitats, from backyards to prairies, and from mature forest to clearcuts. Hens produce large clutches with 10–12 eggs and about half of all nest attempts are successful. In central Illinois, hens may attempt to nest twice. In areas with longer

Continued on back page

Genetic Diversity of Rare Illinois Plants

Of the approximately 3,000 species of plants found in Illinois, around 300 (10%) are threatened or endangered (T&E). Many T&E species in Illinois are considered rare because of habitat destruction, or they are in the periphery of their ranges in Illinois and exist as small and/or isolated populations in the state. Information about T&E species around the state comes from many sources, from amateur botanists to district heritage biologists to researchers. A significant source of information comes from the Illinois Natural History Survey (INHS). For over 20 years the Illinois Department of Transportation has contracted with the INHS to do biological surveys in the areas of future road projects and these surveys have greatly increased our knowledge of the distributions and abundances of T&E species (both plant and animal) throughout Illinois.

Part of my research program within the Center for Biodiversity at INHS is to investigate genetic variation of rare plant species. Understanding this variation provides additional information that cannot be obtained from ecological, morphological, or anatomical data. For example, chemical, protein, and molecular (genetic) markers can be used to determine levels of genetic diversity; genetic diversity can provide a buffer against the complications caused by small population sizes or inbreeding that could ultimately drive the species to extinction. Additionally, genetic markers can estimate a plant's breeding system (selfing vs. outcrossing), help explain its relationship to other species or populations, and decipher its evolutionary history. Another benefit of using genetic markers is that all these questions about populations can be addressed using just one or a few leaves or seeds from each plant sampled.

Author Jason Koontz collects plant specimens. Photo by Mary Ann Feist, INHS Center for Wildlife Ecology

Eared false-foxglove (*Agalinis auriculata*), an Illinois plant whose population genetics are being investigated by INHS researchers. Photo by Jason Koontz, INHS Center for Biodiversity

At INHS, one of the projects investigates the population genetics of the IL-threatened prairie species eared false-foxglove, *Agalinis auriculata* (= *Tomanthera auriculata*, Orobanchaceae). It is a hemiparasite, that is, it can photosynthesize on its own, but uses a plant host for additional water and mineral nutrients. This species is considered rare throughout its range and is listed as endangered in Indiana, Kentucky, Maryland, Minnesota, Ohio, Pennsylvania, and Tennessee, and threatened in Oklahoma. In Illinois, the eared false-foxglove is presently found in 11 counties, but has historically occurred in 25. It is an annual, so plants grow and flower during one season and do not come back the following year (as do perennial plants). Because of its annual habit, the population size of the eared false-foxglove varies from year to year, and it can become locally extinct. This species is one of several being targeted for preservation and re-introduction efforts at the Midewin National Tallgrass Prairie in Will County, IL. With Brenda Molano-Flores and Mary Ann Feist of INHS, I am assessing the levels and patterns of genetic variation among five populations of eared false-foxglove in Illinois. With allozyme markers we have found low levels of diversity, compared to more geographically widespread *Agalinis* species. The genetic data also indicate that eared false-foxglove tends to outcross, and that most of the genetic diversity found in Illinois can be found in individual populations. Allozymes are often not as variable as other genetic markers, so we are currently using RAPDs (Random Amplified Polymorphic DNAs) to assess levels and patterns of genetic variation.

Another project involves some very different questions about a rare species. With Bill Handel of INHS, I am exploring the population genetics of the IL-threatened cliff goldenrod (*Solidago sciaphila*, Asteraceae), which may be hybridizing with another, more common goldenrod, *Solidago hispida* (hairy goldenrod). Cliff goldenrod is endemic to the Driftless Areas of Illinois, Iowa, Minnesota, and Wisconsin. The Driftless Area escaped glaciation during the Pleistocene and therefore contains a

Continued on page 5

Illinois, West Nile Virus, Mosquitoes, and Birds

During the summer of 2002, the news was full of dead crows. These crows were the most obvious victims of West Nile encephalitis, the disease caused by West Nile virus (WNV). WNV first exploded onto the national news in late 1999 when numerous crow deaths and human cases in New York City were found to be caused by the same introduced mosquito-borne virus. Since then, WNV spread rapidly across the country by infected birds, arriving in Chicago and surrounding Cook County in 2001. In 2002, Illinois was the hardest hit state with 877 clinical human cases and 62 deaths from WNV. Virus positive birds, horses, and/or mosquitoes were found in all but two Illinois counties. The majority of human cases were in Illinois, Michigan, and Ohio, suggesting that the east-central states are particularly susceptible to WNV outbreaks. Not content to stop in the Midwest, WNV continued across the country making it as far as the West Coast in late 2002. The only states without cases in 2002 were Utah, Nevada, Arizona, and New Mexico. The upcoming mosquito season will probably fill in those remaining states with new records of WNV.

The primary transmission cycle of WNV is between mosquitoes and birds, with infected mosquitoes occasionally taking mammalian bloodmeals. The main vector for WNV transmission is thought to be the northern house mosquito (*Culex pipiens pipiens*), which prefers to feed on avian hosts. However, the Illinois Natural History Survey Medical Entomology Lab found 12 Illinois mosquito species carrying WNV in 2002, including species which readily bite birds, mammals, reptiles, and amphibians, as well as opportunistic species that feed on whatever vertebrates are abundant. Some of these potential bridge vectors may be responsible for the transmission of WNV to humans and horses. Although humans, horses, and mammals, like canines and squirrels are unable to pass WNV to uninfected mosquitoes, it is not known whether vertebrate species, other than birds, may be part of cryptic transmission cycles.

Without a doubt, the primary victims and hosts of WNV are birds. So far, over 180 bird species have been found positive for WNV in the US. For some species, such as American Crows, WNV is frequently fatal, for others, including Pigeons, there are no visible signs of illness. The relative lethality of WNV to a species does not necessarily mean that species is important in maintaining transmission. Current research is narrowing the field of important bird hosts to a more manageable level.

A crow decimated by West Nile Virus in 2002. Photo by Gabe Hamer, UIUC

An Asian tiger mosquito takes a blood sample from the thumb of Dr. Robert Novak, Director of the INHS Medical Entomology Program. Photo by Michael Jeffords, INHS Office of the Chief

The most important species in this region appear to be the American crow, American Robin, Blue Jay, Brown Thrasher, Common Grackle, Gray Catbird, House Finch, House Sparrow, Northern Cardinal, and Red-winged Blackbird. These species are either efficient transmitters of the virus under laboratory conditions or among the most frequently infected under field conditions. Although many bird species may not be important hosts for WNV transmission, its impact on them may be severe, not only in terms of direct mortality, but also in regard to long-term effects on the reproduction, foraging, and other behaviors of survivors. This is especially true for endangered or threatened species, where a small decrease in population size or reproductive success may be enough to push them towards extinction. Understanding the transmission dynamics of WNV is crucial in determining the risks to particular species as WNV finishes its spread across the country.

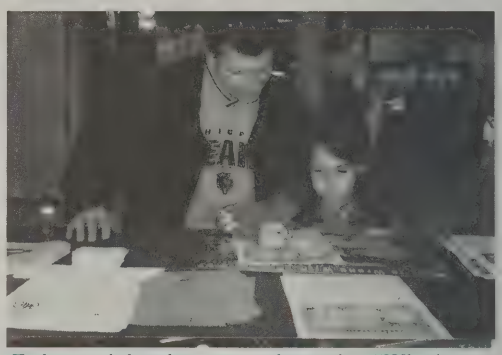
In the near future, WNV is likely to become more abundant in avian populations, and under the right conditions, epizootic and epidemic outbreaks may occur; however, steps are being taken to reduce the risk to humans and horses. Birds on the other hand, will have to continue to rely on their natural immune responses to survive their encounters with WNV. With continued research, efforts to limit transmission and reduce important vectors in key habitats have the potential to keep humans and horses out of the transmission cycle.

Adam Ringia, Richard Lampman, Weidong Gu, and Robert Novak, Center for Economic Entomology

Aquatic Nuisance Species Outreach: Damming the Pathways by Which Organisms Are Spread

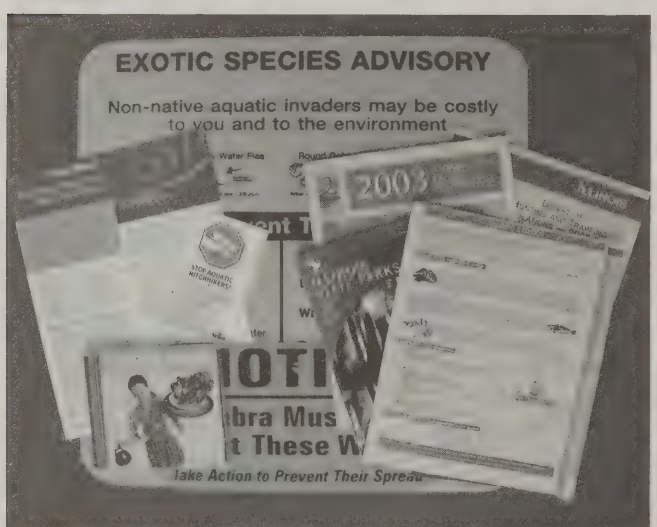
Eurasian zebra mussels blanketing a river bottom, Asian silver carp leaping from the water, Brazilian water hyacinth choking out native plants—sounds like some bizarre exhibit at a museum. Unfortunately these are actual examples of aquatic nuisance species (ANS) that have invaded Illinois waters. A total of 89 species have been introduced into Illinois through a variety of pathways such as recreational water users and the bait fish, plant, and pet industries. In order to prevent the introduction of new species and limit the spread of those already established, behaviors of people connected with each of these pathways must be changed. This can be done largely with outreach. Through a partnership between the Illinois Natural History Survey (INHS) and the Illinois-Indiana Sea Grant Program, we are targeting these pathways via a variety of outreach projects originating from the INHS Lake Michigan Biological Station.

• Recreational water users have transported from lake to lake a variety of organisms including Eurasian water milfoil (*Myriophyllum spicatum*) and zebra mussels (*Dreissena polymorpha*). We have addressed this pathway through several outreach tools including boat-landing signs at Lake Michigan access sites, which remind boaters to clean their equipment and avoid carrying unwanted exotic hitchhikers inland. We have conducted workshops, developed a CD-ROM, and produced a fact sheet specifically for lake associations. These tools facilitate the associations' abilities to educate users of their lakes about ways to prevent the introduction and spread of ANS. We also have created interactive displays for use at conferences (e.g., Illinois Lake Management Association) and outdoor shows (e.g., Chicagoland Outdoors Show) to reach a large number of individuals in this target audience.



Father and daughter try to determine "What's wrong with this picture?" at the Chicagoland Outdoor Show ANS display created by INHS and Illinois-Indiana Sea Grant Program. Photo by INHS staff

• The bait fish industry in Illinois primarily distributes and sells aquacultured fish from Arkansas, which generally are free of ANS. However, some bait suppliers and bait shop dealers supplement their products with wild-caught bait. In order to ensure that the bait they sell is not contaminated with ANS, several outreach materials have been developed for bait suppliers and dealers. Each wholesale bait facility in Illinois has received a copy of our *Hazard Analysis and Critical Control Point (HACCP)* training handbook and video, which describe step-wise protocols that each facility can implement to reduce risk of ANS contamination. Each bait shop has received a sign encouraging employees to inspect all bait being packaged for consumers. As a final safeguard, each shop has also received bait bucket stickers to distribute to customers, which remind anglers to dispose of bait rather than releasing it into a natural waterway. These stickers have also been distributed to anglers by creel clerks at boat shows and through lake associations.



A smattering of our ANS outreach products. Photo by INHS staff

• One of the water garden industry's top-selling plants, water hyacinth (*Eichhornia crassipes*) is considered one of the world's worst invasive aquatic plants. To prevent this and other harmful plants from invading Illinois waters from this growing industry, we are involved in a national project targeted at all aspects of the aquatic plant industry—wholesalers, retailers, and consumers, including water gardeners, natural resource managers, and landscape designers. As part of this project, we produced a brochure for backyard water gardeners, which has been distributed widely throughout Illinois and the U.S. Our next endeavor will be to partner with

Continued on next page

ANS Outreach

continued from previous page

Illinois nurseries to educate consumers about aquatic nuisance plants.

• The introduction of the Oriental weatherfish (*Misgurnus anguillicaudatus*) and Eurasian water milfoil in Illinois' inland waters are just two examples of ANS introductions that can be traced back to home aquarium owners. This problem of invasive plants and animals introduced via the pet/aquarium industry pathway will be addressed through a new national project partnering the pet industry with state and federal agencies. As part of this project, a unified, national, "Don't release!" message will be developed and delivered to consumers on products (e.g., bags in which consumers take fish home) distributed through retail outlets. Outreach tools will also be created to educate retail employees about ANS, so that they in turn can educate their customers. INHS will be involved in this project at both the national and state levels.

Nia Haller of INHS helps an Inland Lake Association member identify invasive zooplankton at an "Exotic Species in Inland Lakes" workshop. Photo by INHS staff

Whether preventing anglers from releasing unwanted bait into the water or encouraging water gardeners to use noninvasive plants in their ponds, outreach plays an essential role in changing ANS-risky behavior and thus can "dam" pathways by which ANS are spread. The outreach projects outlined above are just a few of those in which INHS is involved. Combined, these projects compose a comprehensive initiative to protect our natural resources from invasion by ANS.

Patrice Charlebois and Kristin TePas, Center for Aquatic Ecology

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Genetic Diversity

continued from page 2

unique assemblage of plants, many of which are rare and northern relicts left behind during the last ice age. In Illinois, cliff goldenrod is presently known from only three northwestern counties, and historically from four. Cliff goldenrod is restricted to sandstone and limestone cliffs and outcroppings. The hairy goldenrod occurs above the cliff faces where cliff goldenrod grows and we have observed morphological intermediates. This may indicate that hybridization is occurring between individuals of these two species, as has been suggested by other scientists. Hybridization could be a problem if cliff goldenrod is becoming genetically assimilated into hairy goldenrod. If hybridization is occurring, cliff goldenrod could be hybridized out of existence, or the hybrids could replace both the cliff and hairy goldenrods. We received funding from the Illinois Wildlife Preservation Fund of the Illinois Department of Natural Resources to develop genetic markers to test the hybridization hypothesis. Using several genetic markers, we hope to identify unique fingerprints for the two species. Then we can look a the pattern of markers in the morphologically intermediate individuals to see if they are actually one species or the other. However, if they combine unique makers then hybridization would be supported. The genetic data will help clear up the confusion created by morphologically intermediate individuals readily observed in the field.

Ultimately, knowledge of genetic variation in T&E plant species can help land managers and scientists develop sound conservation plans for ensuring these species will be around for future generations to enjoy or use. One set of data will not give us all the answers, and for rare species it is important to collect many kinds of data (e.g., demography, reproductive ecology, morphology, and genetics) to gain a broader perspective on the biology of rare species.

Goldenrod (*Solidago* species) under investigation by INHS. Photo by Jason Koontz

Jason Koontz, Center for Biodiversity

Species Spotlight

Compass Plant

Susan Post

Look at this vigorous plant that
lifts its head from the meadow,
See how its leaves are turned to the
north, as true as the magnet;
This is the compass flower. . .
(Henry Wadsworth Longfellow,
Evangeline)

Compass plant is the common name of *Silphium laciniatum*, a member of the daisy family. Once common in mesic and drier prairies, today it is often found along roadsides and slightly disturbed sites from Michigan and Indiana, south to Alabama, west to Texas, and north to North Dakota. In 1777, William Bartram, an early botanist and traveler described the plant as, "the most conspicuous both for its beauty and novelty . . . The flower stem, which is eight or ten feet in length, terminates upwards with a long heavy spike of large golden yellow flowers."

Compass plant (*Silphium laciniatum*). Photo by Michael Jeffords, INHS Office of the Chief

Compass plant is one of the largest-leaved plants of the prairie. It has huge basal leaves and a 3- to 8-foot flower stalk. On top of the hairy stalk are several alternate flower heads, each 2.5 to 4.5 inches wide with many yellow petal-like ray flowers surrounding a yellow center with disk flowers. The basal leaves are broadly triangular in general outline, and can be over 1 foot long and deeply divided into a series of narrow segments. The plant's species name, *laciniatum*, is Latin for deeply cut or lacerated and refers to the basal leaves, which resemble a masterpiece worthy of Edward Scissorhands. The basal leaves of the compass plant align themselves in a north-south orientation; this allows the broad leaves to have maximum exposure to the morning and evening sun and minimal exposure to the hot drying noon sun. During a 90°F day, put your hands on the sides of the leaves, they are cool to the touch.

The plant blooms from June to September and usually flowers before big bluestem or Indian grass have reached their mature sizes, making the plant an unmistakable prairie landmark. Compass plant or polar plant (it's other common name) was a plant many pioneer travelers used to find their way across the prairies. A clan of Osage Native Americans, who called themselves Walkers-in-the-Mist, used the tall compass plants to plot their routes across fog-bound prairies. Early wagon train scouts marked trails for their followers by tying flags to the flower's stalks.

The plant's root is equally impressive, attaining a depth of 10 to 15 feet. This enables it to weather prairie droughts and survive prairie burns. Left undisturbed, compass plant can attain a height of 6 to 8 feet every year, die back, and begin the growth cycle again, all due to its incredible root system.

Compass plant is one of 14 species of the genus *Silphium* to be found in the eastern United States. Members of this genus are tall and sturdy and have sunflowerlike blossoms. *Silphium* is the ancient name of a resinous plant, and plants of this genus have a pine-scented resinous sap. William Bartram also described the stems of compass plant when split, noting they "exude a resinous substance which the sun and air harden in semi-pellucid drops or tears of a pale amber colour. This resin possesses a very agreeable fragrance and a bitterish taste, somewhat like frankincense or turpentine; it is chewed by Indians and traders to cleanse their teeth and mouth and sweeten their breath." Beware before you try it as Illinois author John Madison wrote, "Pioneers found that compass plant produced a pretty good brand of native chewing gum. It has an odd pine-resin taste that's pleasant enough, but must be firmed up before its chewed. A couple summers ago I tried some of this sap while it was still liquid. It's surely the stickiest stuff in all creation and I literally had to clean it from my teeth with lighter fluid."

Teachers Guide to "The Naturalist's Apprentice"

Answers:

1. K
2. A, B, C, F, L
3. D, E, H, M
4. B, F, H
5. A, B, F, I, L
6. A, D, H, N
7. D, E, H
8. A, D
9. A, C
10. F, G, M
11. D, H
12. C, D, I, M
13. D
14. H
15. D, O

To read more about uses of Illinois plants, check out the following book from the library: *Life and Lore of Illinois Wildflowers* by William E. Werner, Jr. 1988. Illinois State Museum.

Credits for Images on Next Page

- Carie Nixon—Compass plant
- *Prairie Plants of Illinois* by John W. Voigt and Robert H. Mohlenbrock, illustrations by Miriam Wysong Meryer. Illinois Department of Conservation, Division of Forestry—Blazing star, Goldenrod, Wild strawberry, and Pale purple coneflower
- Dover clipart—Pokeweed, Solomon's-seal, Bloodroot

The Naturalist's Apprentice

Practical Uses of Native Illinois Plants

Carolyn Nelson

Practical Uses of Native Illinois Plants

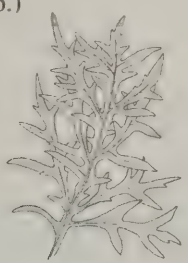
Many native Illinois plants were used by the Native Americans and later by the European settlers. Some are still used today. See how many of the plants in the left column you can match with the uses in the right column. Some plants have more than one use, and some uses apply to more than one plant! You may even know other uses not listed below for some of these plants.

1. Compass plant (*Silphium laciniatum*)
2. Bloodroot (*Sanquinariea canadensis*)
3. Violets (*Viola* spp.)
4. Purple coneflowers (*Echinacea* spp.)
5. Goldenrods (*Solidago* spp.)
6. Sunflowers (*Helianthus* spp.)
7. Blazing stars (*Liatris* spp.)
8. Pokeweed (*Phytolacca americana*)
9. Touch-me-nots (*Impatiens* spp.)
10. Boneset (*Eupatorium perfoliatum*)
11. Morning glories and sweet potatoes (*Ipomoea* spp.)
12. Solomon's-seal (*Polygonatum* spp.)
13. Wild strawberry (*Fragaria virginiana*)
14. Phlox (*Phlox* spp.)
15. Cattails (*Typha* spp.)

A. Stains or dyes
B. To treat toothaches
C. Treatment for poison ivy
D. Food
E. Cancer treatment
F. Treat colds or fever
G. Treatment for malaria
H. Ornamental
I. Treating wounds
J. Basket weaving
K. Chewing gum
L. Control bleeding
M. Pain relief
N. Insecticide
O. Basket weaving

Blazing star

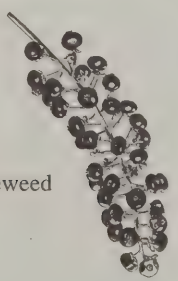
Goldenrod



Compass plant

Solomon's-seal

Bloodroot



Pokeweed

Pale purple coneflower

Wild strawberry

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Turkeys

continued from front page

growing seasons, hens may try up to three nests.

The most limiting factor we observed in central Illinois was the survival of poults. Young turkeys have specific habitat requirements for foraging. Similar to other gallinaceous birds, ideal brood habitat is grass or leguminous vegetation with abundant insects that is tall enough for concealment, short enough for the hen to see over, and open enough at the surface to allow movement. In addition, weather can have a major effect on survival of poults. Two weeks of wet, spring weather that wiped out almost an entire year of reproduction, combined with limited brood habitat in our study areas, resulted in a poult survival rate to six weeks of less than 10%.

While turkeys are not migratory, they roam widely during the course of a year. Annual home ranges averaged about 7 km^2, and several were larger than 25 km^2. The period with the greatest movement is in the spring when winter flocks break up and hens begin searching for nesting areas. Hens show considerable fidelity to winter flocks and often return to the same group each winter. Those that switch winter flocks are important for genetic exchange.

Eastern Wild Turkeys have shown the ability to adapt to a range of habitat conditions, including those of east-central Illinois, but they are forest birds and their ecology is related to forest conditions. Not surprisingly, analysis of habitat selection for turkeys in our study showed that the birds selected forested areas over other available habitats, and that upland forest was consistently preferred to riparian forest. Movement patterns clearly showed the importance of riparian forest for travel corridors. While row crop fields were ubiquitous in our study areas, and waste grains can be an important food source during winter, turkeys confined much of their activity to natural habitats.

Our research suggests a simple model for turkeys in intensively farmed landscapes—that forests determine distribution and grasslands drive abundance. With woodland communities in mind, the status and popularity of the turkey is good news for a number of reasons. Turkeys are an important, and natural, part of our woodlands and their return should lead to better functioning ecosystems. From a management perspective, the popularity of the turkey should be viewed as an opportunity and turkeys thought of as an "umbrella" species to promote conservation of riparian forest communities throughout the state.

Patrick Hubert, Center for Wildlife Ecology

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ILLINOIS NATURAL HISTORY SURVEY

Reports

Autumn 2003
No. 377

INSIDE

Evaluating the Effectiveness of an Electric Dispersal Barrier

The most recent invasive species threatening Illinois' aquatic ecosystems are the bighead and silver carps, two of four species commonly called Asian carps. These fish grow quickly to more than 50 lbs by consuming 30–50% of their body weight each day in small algae and other tiny organisms. They also reproduce quickly and migrate long distances to spawn. Currently, in the Mississippi and Illinois rivers, these Asian carp are spreading rapidly upriver toward the Chicago Sanitary and Ship Canal (CSSC) where they could enter Lake Michigan and affect the entire Great Lakes basin. Because of the immediate danger of Asian carps crossing into the Great Lakes basin through the CSSC and the more general and persistent threat of invasive fishes passing this artificial connection between the Great Lakes and Mississippi River drainages, an electric barrier to fish movement was constructed in the CSSC near Romeoville, approximately 28 miles downstream from Chicago Harbor. Currently, Asian carp have been found about 22 miles downstream of the dispersal barrier location in Romeoville.

This barrier creates a graded electric field that should repel fish as they sense the field, creating a nonlethal barrier. Because optimal barrier performance depends on current velocity, temperature, conductivity, etc., we are evaluating the performance of this dispersal barrier. One evaluation technique is a series of experiments being conducted under controlled conditions that evaluate a scale model barrier emulating the Romeoville barrier. We also are testing combined barrier technologies that focus on the efficacy of an integrated sound-bubble barrier and both technologies combined (electric and sound-bubble) in hatchery raceways at the Illinois Department of Natural Resources' Jake Wolf Memorial Hatchery. Our preliminary results suggest that bighead carp are very sensitive to the electric fields created by the electric barrier, making this barrier a promising technology for preventing further range expansion of this species. The integrated sound-bubble barrier and the combined technology barrier have also given good results by preventing over 90% of fish from moving through each barrier type. We continue to evaluate and modify these barriers to increase their effectiveness with the goal of stopping all attempts to move through each barrier type. Additionally, the com-

Researchers track fish at electric dispersal barrier on the Illinois River. **Photo by Dr. Scudder Mackey, Great Lakes Protection Fund**

Continued on back page

Egg-powdering in Leafhoppers

Leafhoppers, one of the most diverse and abundant groups of plant-sucking insects, use plants not only as a food source but also as a repository for their developing eggs. Like their relatives the cicadas, leafhopper females use their swordlike ovipositors to cut the plant skin and inject the eggs underneath. Having done so, the female usually departs to feed and lay new eggs elsewhere, leaving behind nothing noticeable but a scar on the plant surface. A study, in which I collaborate with Daniela Takiya and Chris Dietrich, focuses on a significantly more complicated maternal behavior displayed by certain New World species from the xylem-feeding leafhopper lineage known as "sharpshooters." Our research fills a gap in the knowledge of leafhopper biology and provides data that can be used in the biological control of pest species, such as the invasive glassy-winged sharpshooter in California. From a broader perspective, by reconstructing the evolution of the unique behavioral, physiological, and structural specializations related to egg-laying in sharpshooters we are seeking to better understand how complex biological innovations evolve.

Figure 1. A female *Oncometopia orbona* (F.), the largest and one of the most conspicuous leafhopper species in the eastern and central U.S., scrapes brochosomes from the white spots on its forewings to the lower surface of a compass plant leaf, under which it has inserted several eggs. **Photo by Roman Rakitov, INHS Center for Biodiversity**

This is how it works. All leafhoppers share a peculiar physiological trait—parts of their excretory system are modified as glands that produce myriads of tiny protein-lipid particles called brochosomes. After hatching and after each shedding of the old skin, leafhoppers use their legs to spread droplets of the brochosome suspension over the new epidermis. The layer of dry particles, hardly visible without a microscope, is water-repellent and protects leafhoppers from getting trapped in their copious liquid excrement, a filtered plant sap. Our study has found that approximately 200 species of sharpshooters also use brochosomes to powder their egg nests. When females of such species become gravid, their glands switch over to production of structurally modified brochosomes. When ready to lay eggs, the female places droplets containing these particles onto special areas of her forewings, covered with short hairs facilitating attachment of the material. Here brochosomes dry as a pair of conspicuous white masses (Fig. 1). Next, the leafhopper starts laying eggs, inserting them under the lower epidermis of a leaf, and scraping the brochosomes off the wings onto the plant with brushing strokes of its hind legs. A closer examination of the rows of spines on the female's legs reveals that, in most such species, the spines that actually do the job of transferring brochosomes are elongate and curved, like the tines of a leaf rake. In males of these species and in both sexes of other leafhoppers, the legs bear only rows of short and straight spines, resembling the teeth of a garden rake. The completed egg nest, which can contain up to 30 eggs, is buried under a spot of white powder (Fig. 2). The function of this coat is not yet well understood. Experiments currently conducted by Walker Jones (USDA) in Texas indicate that it slows down the work of egg parasitoids—tiny wasps which inoculate leafhopper eggs with their own progeny—by making them waste additional time cleaning their body from adhering brochosomes. Other possible functions include protection of the

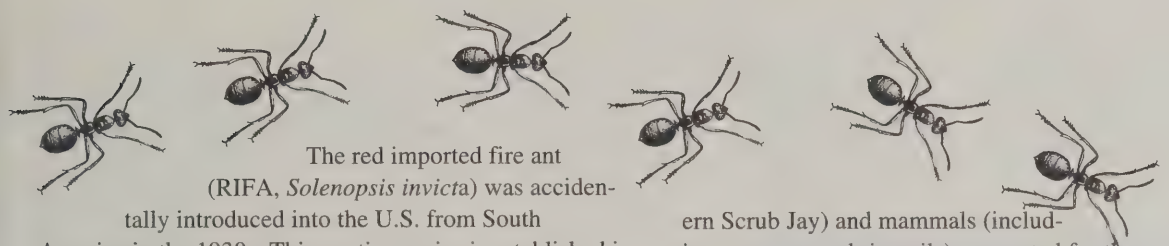
Figure 2. The completed leafhopper egg nest is coated with the white brochosome powder . **Photo by Roman Rakitov, INHS Center for Biodiversity**

wounded leaf from pathogens and facilitating respiration of the eggs.

By screening leafhopper collections of the world for presence of female sharpshooter specimens with brochosome masses on the wings (Fig. 3), we found that the powdering behavior, first described in 1936 and until recently reported in only a few species, is characteristic of 15 genera, of which the majority is confined to tropics of Central and South America and only three extend onto the territory of the U.S. Our analysis, in which we used DNA sequences to reconstruct the genealogical tree of sharpshooters, showed that these genera form a single branch, suggesting that powdering of eggs with brochosomes has been invented by their common ancestor. But how? We think that powdering is derived from the behavior known as grooming or preening, in which insects use their legs to brush contaminants off their bodies. If females of ancestral leafhoppers preened after the hard work of egg laying, brochosomes from the body could have accidentally gotten onto their fresh egg nest and, if such small amounts of ordinary brochosomes could confer even a minuscule increase to egg survival, natural selection might further amplify the efficiency of the process, leading to the evolution of the physiological and structural modifications and sophisticated powdering rituals we observe today. This hypothesis still needs to be supported by observations of the closest relatives of the "powdering" leafhoppers,

Continued on page 7

Impact of Red Imported Fire Ants on the Black-capped Vireo, an Endangered Species



The red imported fire ant (RIFA, *Solenopsis invicta*) was accidentally introduced into the U.S. from South America in the 1930s. This exotic species is established in the southern U.S., from Texas and Oklahoma to Florida and North Carolina, and its range is still expanding. Red imported fire ants are effective predators of many taxa, and they pose a serious threat to both terrestrial and aquatic communities. For example, some studies have shown that RIFA affect arthropod diversity and abundance. This finding, in turn, has led others to suggest that RIFA may negatively affect native bird species indirectly via competition for insect prey. More recently, laboratory studies suggest that RIFA may alter the behavior and decrease the survivorship and body mass of the Northern Bobwhite (*Colinus virginianus*). However, how RIFA affect wild birds is still controversial. Understanding how RIFA impact natural avian populations is essential for effective management. Here, we describe our research on the impact of RIFA on the reproductive ecology of a federally endangered bird species, the Black-capped Vireo (*Vireo atricapillus*).

The Black-capped Vireo is a small, largely insectivorous bird that inhabits dense thickets of oak scrub habitat. Although it nests predominantly in oaks, many other plant species are also used. The bird's open cup nest is suspended from a forked branch 0.4–1.3 m above the ground. The species has been extirpated from most of its historic range, and breeding populations in the U.S. are now restricted to Oklahoma and Texas. Brood parasitism by the Brown-headed Cowbird (*Molothrus ater*), which lays its eggs in the nests of other bird species, coupled with habitat loss, caused the endangerment of the vireo. Recently the red imported fire ant has colonized the part of Texas that includes the 88,890-ha army base, Fort Hood, which currently contains the largest breeding population of the Black-capped Vireo. In an investigation of the reproductive ecology of the species, from 1998 to 2001, 139 vireo nests were monitored with infrared video cameras. We analyzed that video footage to determine the influence of predation, particularly that by red imported fire ants, on vireo behavior and nesting success.

Predation accounted for over two-thirds of nest failures in the study. RIFA was the leading predator, accounting for 38% of predation. The Texas rat snake *(Elaphe obseleta lindheimeri*) was the second leading predator, causing 36% of nest failures. Birds (primarily the Western Scrub Jay) and mammals (including raccoons and ringtails) accounted for the remaining predation. Two nests were visited by a second predator during RIFA activity. In the presence of RIFA, an eastern woodrat (*Neotoma floridana*) nicked one of the eggs but failed to depredate the clutch. A Texas rat snake, however, consumed all three nestlings while RIFA swarmed the nest. RIFA were present for four hours prior to snake predation and 15 minutes before the woodrat approached the nest. In both cases, adult vireos were actively defending nests against the RIFA attack. It is possible that the increased activity during this defense may have alerted secondary predators to the nest.

RIFA activity was independent of vireo nest height and substrate type (tree or shrub species). RIFA attacked vireo nests at night, typically beginning just after midnight. On average, RIFA remained at nests for at least 23 hours after the initial attack. During attack, adult vireos engaged in prolonged and energetically expensive defense against RIFA at a time when they would otherwise be sleeping. Ultimately, all attacked nests were abandoned, causing mortality of the eggs and offspring.

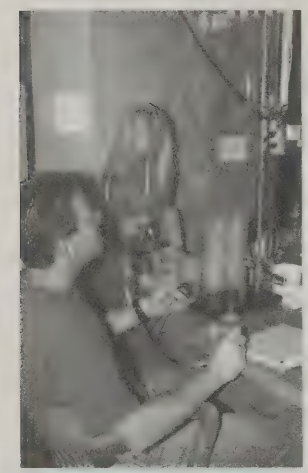
The initial response of adult vireos to RIFA was acute and had the appearance of a flight or fight response. During nest defense, vireos spent significantly more time pecking at and removing RIFA from the nest than engaging in brooding, alert perching, hopping, and flying. Adult vireos expended 2.4 times more energy during nest defense than would be expected while they were sleeping. Vireos expended the most energy pecking at ants and flying to and from the nest. Nest defense continued for hours through the night and into the following morning. No such prolonged defense occurred in the presence of vertebrate predators. Adult vireos likely received bites and stings (envenomization) while defending the nest from swarming ants. Such bites cause painful pustules and secondary infection for humans. Similar costs may be incurred by vireos. Despite their energetic defense, adult vireos never prevented nest failure when RIFA

Continued on page 7

"Eat and Run:" Soybean Herbivory Influences Western Corn Rootworm Behavior and Egg-laying

The western corn rootworm, (WCR), *Diabrotica virgifera virgifera*, is a serious insect pest of corn. Before the mid-1990s, WCR adults displayed strong fidelity to cornfields as both feeding and egg-laying sites. This egg-laying fidelity and the requirement that larval WCR feed on corn roots during their development has long been exploited by pest managers through the practice of crop rotation. By annually alternating production of corn with a crop like soybean that does not support larval development, the WCR lifecycle can be interrupted. By not planting corn in the same field in successive years, excellent WCR control can be achieved. If corn is grown year after year on the same ground, soil insecticides can be applied at planting to protect corn roots from larval feeding injury.

Western corn rootworm beetles feeding on soybean foliage. **Photo by Joseph Spencer, INHS Center for Economic Entomology**



Tim Mabry, UIUC student in crop sciences, uses suction device to capture WRC in lab. Photo by Joseph Spencer, INHS Center for Economic Entomology

Over the years, enthusiastic adoption of crop rotation as a less costly (soil insecticides cost ca. $15.00–17.00 per acre) and more environmentally benign alternative to insecticide, exerted a strong selection favoring female WCR with less fidelity to cornfields. Under a strict rotational scheme, only females that lay eggs in the rotated (noncorn) crop would have surviving offspring. By 1995, a "crop rotation-resistant" WCR population that circumvented rotation by laying eggs in rotated soybean fields caused devastating root injury to rotated corn in nine east-central Illinois counties. Since 1995, the region affected by the rotation-resistant WCR has expanded to more than 30 east-central and northern Illinois counties as well as the northern two-thirds of Indiana and parts of Ohio and southern Michigan.

Unlike rotation-susceptible WCR (found in western Illinois), beetles from the rotation-resistant population are common daily visitors to soybean fields where their consumption of soybean foliage can be conspicuous. Despite being a poor food (an exclusive soybean foliage diet is equivalent to starvation and kills most WCR in 4–5 days), over half of the beetles in soybean fields have soybean foliage in their gut contents. Beetles avoid the negative consequences of soybean herbivory by moving between corn and soybean fields and eating a mixed diet of corn and soybean tissue. The shared ability of beetles from either population to recover from brief exposure to poor nutrition by feeding in cornfields likely helps to insulate the adventurous egg-laying individuals from potentially fatal food choices.

Studying the effects of soybean herbivory on movement and egg-laying may help us understand the mechanisms of rotation resistance.

We studied the effects of mixed diets on WCR biology by providing beetles with corn and soybean diet on alternate days. One consequence of soybean herbivory was an increase in WCR activity; beetles are more likely to move or fly after feeding on soybean foliage than after eating corn tissue. Increased activity is a common insect response to nutritional stress. We also observed that beetles were more likely to lay eggs during days when they were exposed to soybean foliage than on days when corn was available. When the stress responses of rotation-susceptible and resistant beetles were compared, we learned that beetles from resistant populations were less responsive to the stresses associated with alternating diets and nutritional uncertainty than the rotation-susceptible insects.

We hypothesize that when an egg-laden female WCR from corn enters a soybean field, she experiences a stressful environment that can stimulate her to lay eggs. Greater sensitivity to soybean field stress among the rotation-susceptible population may rapidly drive them back into cornfields before accumulating stress can stimulate the problematic egg-laying in soybean fields that occurs in the resistant population. Continued observation, monitoring, and comparison of rotation-susceptible and resistant populations will improve our understanding of mechanisms at the "root" of WCR resistance to crop rotation.

Joseph L. Spencer and Eli Levine, Center for Economic Ecology; Timothy R. Mabry and Scott A. Isard, Univeristy of Illinois

Understanding the Public in Natural Resource Management

The Human Dimensions Research Program in the Center for Wildlife Ecology of the Illinois Natural History Survey conducts research on public attitudes related to natural resource policy and management. In 2003, we have conducted nine separate research projects, ranging from surveys of deer hunters and waterfowl hunters for the Illinois Department of Natural Resources to a study of public perceptions of water quality in Illinois for a private foundation. The following are summaries of two recent projects.

Perceptions of Chronic Wasting Disease Among Illinois Deer Hunters

A study of 2,683 (79% response) Illinois deer hunters' attitudes toward and understanding of Chronic Wasting Disease (CWD) in white-tailed deer in Illinois was conducted during spring 2003. Most hunters (96%) were aware of CWD, but fewer could state they were aware of CWD in a particular state, including Illinois (77%). Higher risk ratings were given to West Nile Disease (7%), Lyme's Disease (5%), or having a heart attack while hunting (5%) than CWD (3%). Hunters did perceive CWD to be a threat to the Illinois deer herd (33% were "very concerned"). Most hunters (63%) did not foresee any change in their hunting participation for the 2003 firearm season due to CWD, 15% thought they would hunt a CWD-free county. A majority of hunters (54%) expressed a degree of uncertainty as to the potential risk of CWD to humans, and 185 felt it could be contracted by eating meat from infected animals. Hunters expressed potential changes in behavior with increased infection rates of CWD in deer in the county where they hunted. Based on the responses to this study, approximately 5% of hunters can be expected to drop out of deer hunting if CWD is found in the county next to or in the county where they hunt.

Attitudes of East-central Illinois Residents Toward Tallgrass Prairie Restoration at Allerton Park

Homeowners in Champaign and Piatt counties feel prairies are a part of Illinois' heritage and support creating prairies on state-owned lands. Results of a recent mail survey of residents in Champaign and Piatt counties show support for the pending sale of 1,300 acres of University of Illinois land at Allerton Park to the Illinois Department of Natural Resources (IDNR). The land in question will be restored to prairie by the IDNR if the land sale is completed.

When asked if they supported the land sale, almost half of all respondents (47%) supported the move, 27% were opposed, and 26% were undecided. Breakdown by counties showed 55% of Champaign County residents supported the sale, whereas 16% were opposed. In Piatt County 32% of residents supported the sale and 46% were opposed. Reasons for opposing the sale cited most often included: land should remain in agriculture (24%), displacement of tenant farmers (18%), and loss of taxes to area (14%).

Most respondents (65%) felt that preserving prairies provides future generations with a natural heritage. When asked if purchasing land for recreation and wildlife was a sound investment, 71% of respondents agreed and 13% disagreed. A majority of people (57%) felt that natural areas increase property values, whereas 18% disagreed. Residents were somewhat split on the statement that a sound economy is more important than protecting wildlife: 45% agreed and 39% disagreed. When asked if they would visit the site if it was completed as planned, a majority of residents in both counties (74% in Champaign and 56% in Piatt) stated they would visit the site.

Most residents surveyed (82%) stated they supported the creation of natural areas and wildlife habitat on state-owned land in east-central Illinois, and a majority (80%) supported restoring prairies on state lands in the area.

When asked questions about landowners' ability to use their land, most residents (59%) supported a landowner's decisions to sell their land to IDNR, whereas 22% said they wouldn't care either way, and 18% objected to the idea. Most people (79%) felt that landowners should have more control over how their land is used, and most (70%) also believed a landowner had the right to use their land as they see fit.

Craig Miller, Center for Wildlife Ecology

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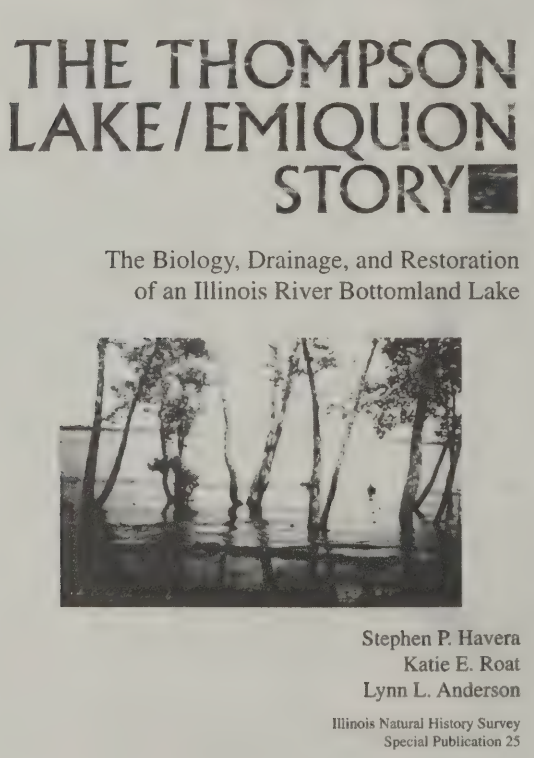

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By

Stephen P. Havera, Katie E. Roat, and Lynn L. Anderson

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Egg Powdering

continued from page 2

which may have retained the ancestral preening behaviors of females. Observing behaviors of these hard-to-collect tropical insects will be a challenge.

Another challenge is to explain why, if the selection worked to maximize the efficiency of powdering, there are among "powdering" species some with specialized brochosomes and wings but with ordinary legs, some with specialized legs and brochosomes but ordinary wings, some with specialized legs and wings but ordinary brochosomes, and finally some with only specialized brochosomes. One possibility is that modifications to these structures evolved independently and somewhat differently in different related lineages. Our results suggest an alternative scenario: multiple secondary losses of individual specializations (such as reversal to the ordinary leg structure) or the powdering behavior as a whole. For example, within the North American grassland genus *Cuerna*, powdering has been lost independently no less than four times. The species that have lost the behavior can display vestigial elongation of the female leg spines or even vestigial powdering strokes during egg-laying but never produce specialized brochosomes nor place anything onto their wings. If powdering is an ingenious protective strategy, why does it get lost? Recent studies which traced evolution of various traits in different organisms indicate that losses are more common than was previously thought. The puzzling diversity of egg-laying specializations in sharpshooters can be used as a model to study the loss of a biological function in three dimensions: structure, physiology, and behavior.

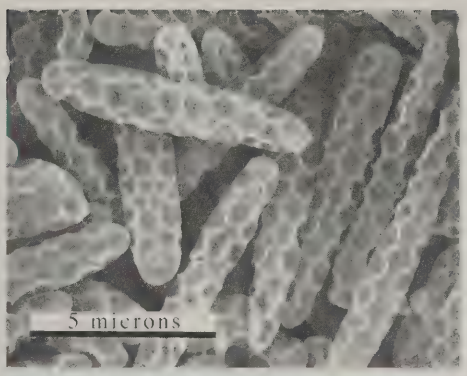
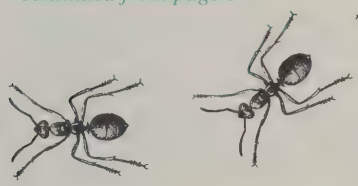


Figure 3. A scannining electron micrograph (SEM) of brochosomes. SEM courtesy of Roman Rakitov, INHS Center for Biodiversity

R.A. Rakitov, Center for Biodiversity

Fire Ants

continued from page 3



swarmed nests. All nests with RIFA activity at either the egg (33%) or nestling (67%) stage of the nest cycle failed to fledge vireos. Adult vireos abandoned all nests with RIFA activity and all clutches subsequently failed to hatch, except for one. In this case, the eggs hatched while RIFA were still at the nest and RIFA depredated the hatchlings minutes after hatching. Eggs were incubated significantly less often while RIFA were at a nest than prior to attack. At one nest, an adult vireo grasp-ejected two cracked eggs out of her nest following nine hours of defense. We were unable to determine whether she punctured the eggs to eject them from the nest or did so inadvertently while pecking at ants. Regardless, eggs were in good condition prior to, and puncture-ejected during, RIFA activity.

When RIFA attacked, nestlings responded by moving erratically in apparent distress within the nest until dead (motionless). The time for nestlings to die increased significantly with nestling age. Time until nestling mortality ranged from eight minutes (one-day-old nestling) to three and a half hours (nine-day-old nestling). At one nest, two of three nestlings were motionless (assumed dead) in response to RIFA, while the third ejected itself out of the nest. Vireos are known to fledge prematurely in response to predators.

These findings suggest that RIFA negatively impact Black-capped Vireos directly, via nest abandonment and mortality of eggs and nestlings. In addition, nest defense by adults leads to an acute and large increase in energy expenditure, coupled with envenomization, incurred during prolonged nest defense. However, the response of the woodrat to RIFA activity suggests that RIFA may also indirectly benefit Black-capped Vireos. RIFA appeared to deter this small mammalian predator. Other studies indicate that RIFA shift foraging patterns and induce trap mortality of small mammals. Positive indirect effects of RIFA on Black-capped Vireos could arise via reductions in the population size of other predators (e.g., *Rattus* and other vertebrate predators). Positive indirect effects could also arise through changes in a predator's or a competitor's habitat selection and foraging ecology. While it seems unlikely that such positive indirect effects could outweigh the direct negative effects, these positive effects warrant investigation.

Our study found strong negative impacts of RIFA on the Black-capped Vireo. This in turn raises the possibility that RIFA may affect co-occurring bird species similarly. With the predicted global range expansion of RIFA, management must be employed to deter the spread and future success of this invader.

Steven J. Taylor and Christopher J. Whelan, Center for Biodiversity; Jennifer E. Smith, Michigan State University; Michael L. Denight, Engineer Research and Development Center, U.S. Army Corps of Engineers, Champaign, IL; and Mike M. Stake, University of Missouri

Species Spotlight

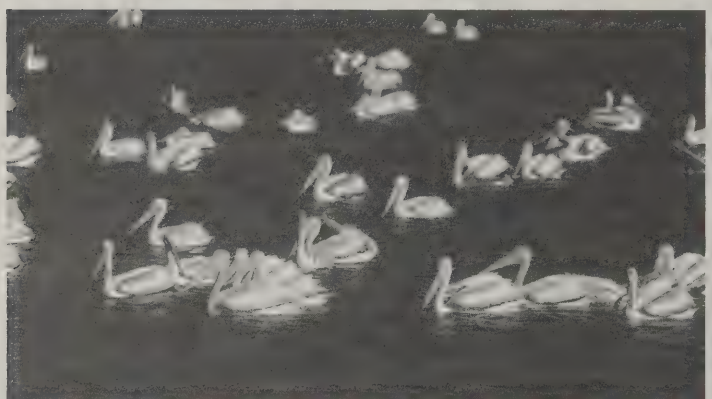
American White Pelican

Charlie Warwick

. . . Nothing else flies like that [White Pelicans], serene, untroubled, almost daring the air to throw them an updraft so that they can make a subtle, nearly invisible adjustment to their flight feathers and continue unperturbed. . . .
—*Peter Cashwell, The Verb 'To Bird'*

The American White Pelican (*Pelcanus erythrorhynchos*), the huge, majestic flier described above is a member of the bird Order Pelecaniformes that contains six families, including Anhingas, Cormorants, Tropic Birds, Boobies, and Gannets. All birds in the Order are distinguised by having all four of their toes connected by webs, bills that are as long or longer than their heads, and expandable throat pouches for catching and holding prey.

American White Pelicans landing in an Illinois lake. Photo by Michael Jeffords, INHS Office of the Chief



American White Pelicans congregate to feed. Photo by Michael Jeffords, INHS Office of the Chief

American White Pelicans live on the coasts of the U.S. as well as lakes and rivers throughout the interior of the country. They are annual migrants in Illinois, usually arriving in the state in May and staying until September and October. Their autumn migration takes them to wintering grounds as far west as northern California and as far south as the island of Trinidad in the Caribbean. They are strong fliers who alternate flapping and gliding and they can soar on thermals like hawks during migration at speeds up to 30 miles per hour. They migrate in "V" formation, often soaring to great heights. In Illinois, White Pelicans have been observed migrating in flocks that number in the hundreds to thousands.

Illinois American White Pelicans can be found along rivers and large inland lakes throughout the state. They seem to be more abundant in the western part of the state, especially along the Illinois and Mississippi rivers, but they have also been seen in the Chicago area, at Clinton Lake in east-central Illinois, at Carlyle Lake in southern Illinois, as well as at ponds and gravel pits. White pelicans may range up to 50 miles from their base when feeding.

These are large birds with bodies up to 5 feet in length, bills that reach 14 inches, wings that measure 22 inches from front to rear edges, and wing spans up to 9 feet. Their heads are white with distinctive throat pouches, the necks are long, and the wings are white with black tips. White Pelicans are a dramatic sight when making a low glide across the water. Writer Peter Cashwell, taking a bit of literary license with the large stature of White Pelicans, states, "If pelicans were drivers, they'd own huge, rectangular American luxury cars with plush interiors; they would get into the interstate's passing lane at the first opportunity and would set the cruise control at eighty, then lean against the headrest, drape one wrist over the top of the steering wheel, and look out at the traffic under heavy-lidded eyes, waiting for their destination to roll up over the horizon."

White Pelicans usually build their nests in a depression on the ground, although some have been known to use trees. The females lay one to five cream or blue-white eggs that measure three and a half by two and a third inches. The eggs incubate in 28–30 days. The young are cared for by both parents who feed them out of their pouches. The baby birds almost disappear inside their parent's throat pouches as they feed on a diet almost exclusively of fish.

Unlike their close relative the Brown Pelican, which dives to catch prey, adult White Pelicans either wade in shallow water or swim and submerge their pouches to scoop up a meal. If they are swimming when they feed, they act like dabbling ducks, tipping their heads under water to secure food in their bills. Pelicans will often work as a group to corral fish.

Only a couple of decades ago, White Pelicans were in danger of extinction because formation of their egg shells was being ruined by the pesticide DDT, which was ingested in their food. Since the use of DDT and other environmentally dangerous chemicals has been banned, the numbers of White Pelicans in Illinois have rebounded and are now among the highest recorded for the state.

The Naturalist's Apprentice

Pelican Math

Carolyn Nixon

Pelican Math

Using the pelican facts listed below, see if you can answer the following questions. (Hint: The answers to earlier questions may help you answer the later questions).

An adult American White Pelican weighs about 20 lbs and consumes 3 lbs of small fish, salamanders, frogs, and aquatic insects each day. It will live about 14 years. While its bill can hold 5 gallons, the stomach will hold only 2 gallons. A pelican can usually catch what it needs to eat in a day by 8:00 or 9:00 a.m. A female pelican usually lays two eggs, but often the parents are able to raise only one young. The chick stays in the nest for 25 days, during which it consumes about 150 lbs of food. The parents continue to feed their offspring until it is able to fly at about 10 weeks old. Parent birds often commute up to 50 miles between nesting grounds and feeding areas.

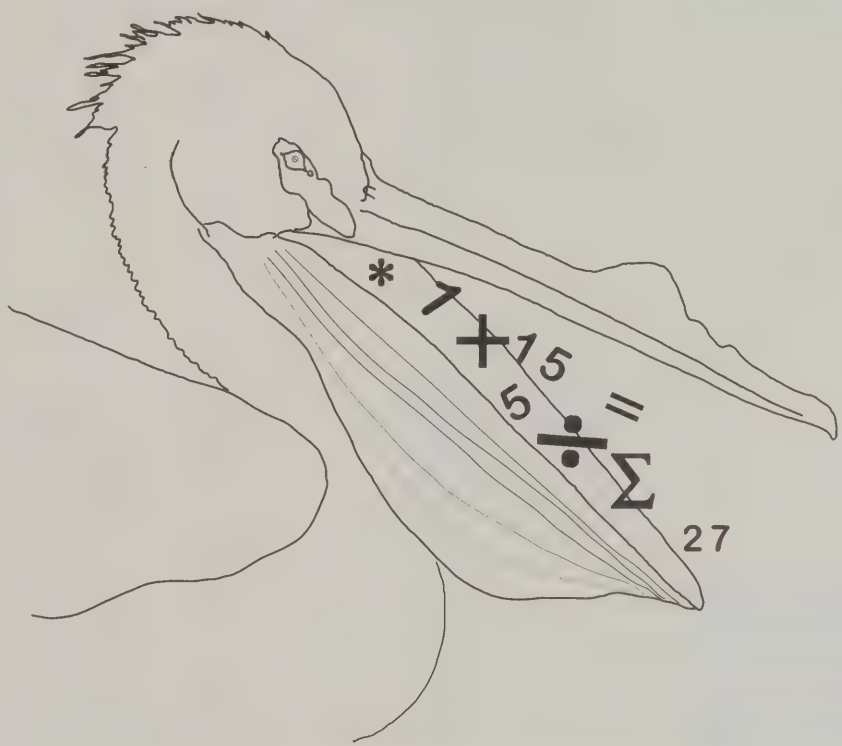
1. On average, how much does a pelican chick eat each day before it leaves the nest?

2. How many pounds of fish and other aquatic organisms must a pair of pelicans catch in one day when they have a chick in the nest?

3. If the pelicans are feeding on minnows that weigh 0.5 oz each, how many minnows must an adult Pelican eat in a day?

4. If a pelican chick will eat the same amount of food as an adult once it leaves the nest, how many pounds of fish must it eat from the time it hatches until it can fly?

5. How many 0.5-oz minnows would an American White Pelican eat in a lifetime?



Pelican Math Answers

1. 6 lbs (150 ÷ 25, or 6 lbs)

2. 12 lbs (each adult eats 3 lbs, and the chick eats 6 lbs)

3. 96 minnows (3 lbs of fish x 16 oz per lb, or 48 oz; 48 ÷ .5 = 96)

4. 285 lbs (first 25 days it ate 150 lbs; 10 weeks = 70 days; 70 days - 25 days = 45 days; last 45 days it ate 3 lbs each day, or 45 x 3 = 135 lbs; 150 lbs + 135 lbs = 285 lbs)

5. 492,960 (14 years x 365 days per year = 5,110 days; 5,110 days - 25 = 5,085 days; first 25 days it ate 150 lbs; 150 lbs x 16 oz per lb = 2,400 oz; 2,400 oz ÷ .5 oz per minnow = 4,800 minnows; so it ate 4,800 minnows its first 25 days; it ate 96 minnows a day for the next 5,085 days, or 96 x 5,085 = 488,160 minnows; 4,800 minnows + 488,160 minnows = 492,960 minnows)

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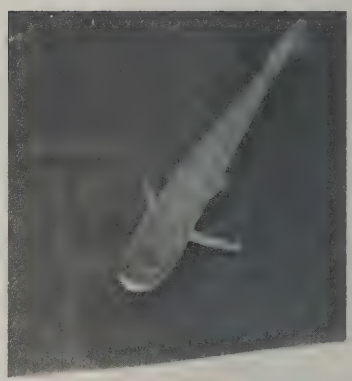
Electric Barrier

continued from front page

bined technologies barrier is an appealing approach because it provides redundancy in the event one or the other technologies physically fail or do not stop the movements of bighead carp or other undesirable species.

In the field, we have been following movements of common carp (a surrogate for the invasive carps) tagged with combined radio/acoustic transmitters in the vicinity of the dispersal barrier. To date, we have tagged 79 fish. We are following the common carp using a combination of fixed receivers immediately upstream and downstream of the dispersal barrier to detect any movement across the barrier, and using mobile tracking by boat. Since November 2002, we have detected 75 of the 79 tagged fish. One tagged fish crossed the barrier on April 3, 2003. This fish was likely helped through the electric field by a commercial barge passing through the electric field at the same time as the fish crossed the barrier. This fish passage may be an indication that commercial navigation traffic can move fish across the field because of the strong propeller thrust from these barges and/or because the large steel hulls change the shape and strength of the electric field.

Since April, no other tagged common carp have passed through the barrier. We will continue to gauge the effectiveness of the dispersal barrier for the next two years. We expect that our work will provide the detailed information to maximize the effectiveness of the dispersal barrier before Asian carps move into close proximity of the dispersal barrier. An effective barrier will close down this avenue of expansion of the Asian carps into the Great Lakes and also keep future invasive fishes from crossing this artificial linkage between the Mississippi and Great Lakes drainage basins. The same technology, if effective in this demanding application, could be applied worldwide.



A bighead carp attempting to move through the experimental electric barrier at Jake Wolf Memorial Fish Hatchery. Photo by Ronald Taylor

John M. Dettmers and Mark A. Pegg, Center for Aquatic Ecology

Illinois Natural History Survey Reports is published quarterly by the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the Illinois Department of Natural Resources.

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Reports

Winter 2004
No. 378

INSIDE

From Tiny Acorns...

Oaks (*Quercus* sp.) are declining in their dominance as canopy species in many midwestern hardwood forests. Even where oaks are still prominent in the forest canopy and acorn production appears normal, the proportion of oak seedlings and saplings in the understory does not seem adequate to maintain oaks as a dominant canopy species. Oak regeneration seems to be least successful on mesic sites where faster-growing, shade-tolerant species such as maples (*Acer* sp.) dominate the understory. Some researchers have predicted that slow-growing, mast-producing trees such as oaks and hickories (*Carya* sp.) will, in large part, be replaced in the canopy by mesophytes, particularly maples, within the next 50 years. A decrease in the abundance of oaks could have cascading negative ecological effects because acorns are one of the most important fall and winter foods to wildlife in many deciduous forests.

INHS mammalogist Ed Heske digs for acorns in oak study enclosures. Photo by John Taft, INHS Center for Biodiversity

View of enclosures at one study site. Photo by John Taft, INHS Center for Biodiversity

Studies of oak regeneration have focused mainly on factors affecting the recruitment of saplings into the canopy. Considerable evidence has demonstrated how fire suppression and increased herbivory by white-tailed deer (*Odocoileus virginianus*) may play major roles in lowering the abundance of oak seedlings and saplings. Earlier stages of oak recruitment, such as acorn survival and germination, have received little attention from researchers. Some acorn consumers, particularly white-tailed deer, have become increasingly abundant in recent decades, and others, such as white-footed mice (*Peromyscus leucopus*) and many tree squirrels (*Sciurus* sp.), may reach higher densities in small forest fragments than in extensive forests. Estimates of the amount of the acorn crop consumed annually by these species are few and varied, but sustained increases in populations of these mast consumers could contribute to low rates of oak seedling recruitment.

We conducted an experimental study of acorn survival, germination, and oak seedling recruitment at four study sites in east-central Illinois: Allerton Park, Hart Woods, Brownfield Woods, and the Vermilion River Observatory (VRO). At each site, we constructed 12 experimental exclosures made of steel and wood frames covered by hardware cloth. Three exclosures were designed to keep out all mammals, three contained small holes at ground level to allow entry by mice but no larger mammals, three had gaps at ground level to allow entry by squirrels and mice but not deer, and we left three plots open to all mammals. In the falls of 2001 and 2002, we buried 25 individual northern red oak (*Quercus borealis*) acorns in each plot to simulate squirrel caches, and we mixed 25 acorns with the leaf litter on the surface. We counted surviving acorns the following

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Evaluation of Dam Removal on the Fox River, Illinois

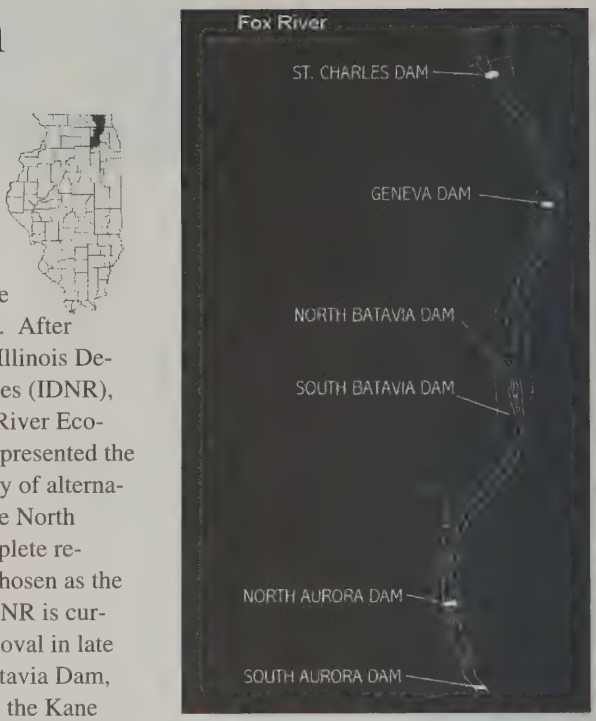


Figure 1. Location of the Fox River and sites sampled for evaluation of dam removals.

There are currently over 76,000 dams listed in the National Inventory of Dams. Many of these structures were built prior to World War II and have since fallen into disrepair. As these dams continue to age and as society's demands change, dam removal is increasingly becoming an option for river restoration. Unfortunately, there is a lack of empirical knowledge on the short- and long-term ecological effects of dam removal. Faced with uncertainty over the potential impacts of such actions, communities are increasingly wary of removing structures that are often viewed as permanent features of the landscape. As communities and resource managers are faced with decisions regarding the fate of aging dams, there is a critical need for information on the expected outcomes of dam removal.

Dams are known to drastically alter the physical, chemical, and biological components of river systems. Dams create slow-flowing depositional zones that trap sediment and nutrients in the upstream impoundment. Sediment deposition combined with the lack of habitat diversity results in areas unsuitable for many stream fauna. Additionally, small impoundments create conditions ideal for the production of high biomasses of planktonic algae, which can result in widely fluctuating dissolved oxygen levels that often reach lethal limits for many aquatic organisms. One of the most obvious effects of dams is the restriction of organism movement, thereby preventing various life stages from reaching critical spawning, nursery, feeding, or over-wintering habitats. Furthermore, dams fragment river systems, leading to reproductive isolation and local extinction of some species.

Two dams on the Fox River, a tributary of the Illinois River in northeastern Illinois (Fig. 1), are currently being considered for removal. The North Batavia Dam was built in the early 1900s to provide water power to the Challenge Windmill Company and the South Batavia Dam was constructed in 1913 to provide cooling water to a plant that powered the Chicago, Aurora, and Elgin Railroad. In the mid-1900s, the mills and factories were decommissioned and the dams were allowed to fall into disrepair. After several years of review, the Illinois Department of Natural Resources (IDNR), with the support of the Fox River Ecosystem Partnership (FREP), presented the City of Batavia with a variety of alternatives regarding the fate of the North Batavia Dam. In 2002, complete removal of the structure was chosen as the preferred alternative, and IDNR is currently planning to begin removal in late 2004 or 2005. The South Batavia Dam, which is currently owned by the Kane County Forest Preserve District (KCFPD), is also scheduled for removal sometime in 2004 due to a large breech in the structure during an autumn 2002 flood.

The Illinois Natural History Survey is investigating the effects of these two dam removals on the Fox River ecosystem through funding from the IDNR Division of Water Resources. Whereas previous studies have focused on the effects of dam removal on physical habitat and/or a portion of the biota, this investigation is examining multiple ecological components of dam removal. Reference sites above and below dams not expected to be modified during the course of this study are being monitored in order to control for other changes in the water-

Continued on next page


Dam on the Fox River at St. Charles, IL. Photo by Hope Dodd, INHS Center for Aquatic Ecology

Dam Removal

continued from previous page

shed (climate, flow patterns, etc.) not associated with the treatment (dam removal) effects. This design results in three impacted reaches (areas affected by dam removal) and two reference reaches (areas unaffected by dam removal, Fig. 1), which are to be monitored closely both before and after dam removal.

The current study is monitoring short- and long-term changes in physical/chemical habitat, invertebrate and fish community structure, and fish movements associated with dam removal or modification. Water chemistry variables (i.e. temperature, dissolved oxygen, pH, and conductivity) are monitored above and below the two Batavia dams and above and below the Geneva dam (reference). Physical habitat is measured at all sites using both qualitative and quantitative methods. Following dam removal, we anticipate water chemistry variables that currently fluctuate widely at impounded sites to stabilize and assume patterns similar to those observed at free-flowing sites. Decreased depth, increased flow, and increases in sediment size are expected to be observed at impoundment sites, as well as increases in qualitative habitat scores.

As a result of changes in habitat and water chemistry associated with dam removal, the biotic community is expected to change substantially. Due to their short life cycles and high growth rates, the response from aquatic invertebrates in particular is likely to be rapid. During the summer and fall of each year, aquatic insects are being sampled from shallow substrates at every site using kicknets and Hess samplers. At impounded sites, deep sediments are sampled for invertebrates using Ponar grabs. Mussels are also being surveyed at each impacted and reference site. Fish assemblages are evaluated at each site during summer using both boat and backpack electrofishing. Species richness and abundance will be determined based upon these samples and an Index of Biotic Integrity (IBI) will be calculated. This metric gives an overall stream quality rating to each site based on the composition of the fish community. The IBI at impounded sites is expected to increase following dam removal as more intolerant species colonize these areas. Growth rates of selected fish species will also be examined to ascertain the effects that changes in habitat and prey availability may have on the growth of fish.

Steve Butler and Hope Dodd measure fish and prepare it to receive an elastomer mark on its operculum. Photo by Jeff Butler, INHS Center for Aquatic Ecology

As a component of our evaluation of the effects of dam removal on fish communities, fish movements are being monitored using two methods. In spring, summer, and fall, eight species (smallmouth bass, channel catfish, common carp, walleye, and four redhorse species) are given site-specific marks using colored elastomer tags (injectable plastic dyes visible through the skin). Fish are marked and then released, with later sampling allowing us to recapture marked fish and determine the extent to which fish are capable of passing dams. This will provide a measure of the movement within a specific river reach. The second method for tracking fish movements is radiotelemetry. Smallmouth bass, channel catfish, and common carp have been surgically implanted with radio-transmitters in two impacted (below the South Batavia Dam and above the North Batavia Dam) and one reference (above the Geneva Dam) reach. Weekly tracking will ascertain individual home range sizes, seasonal movements, and habitat preferences.

Baseline data collected during 2002–2003 indicate that impoundments in the Fox River provide lower habitat quality than free-flowing sites. They also contain less diverse and more tolerant invertebrate and fish communities than free-flowing sites. Sport fish (smallmouth bass, walleye, and channel catfish) are less abundant in impoundments. The South Batavia sites have undergone dramatic changes since this dam was partially removed by a flood in autumn 2002. The impoundment has become shallower and flow has greatly increased. Much of the fine sediment previously located in the upstream impoundment has been transported downstream and gravel bars are beginning to form at this site. The invertebrate community is beginning to respond to these changes, and a more diverse fish community was observed at this site during 2003. Further study will provide additional insight into the ecological effects of dams, and results of our study will help guide management decisions regarding removal of other dams throughout Illinois.

Steven E. Butler, Hope R. Dodd, and David H. Wahl

Biological Control and Genetically Modified Crops

Biological control, or the use of beneficial predatory insects to control crop pests, is an important practice that helps to reduce pesticide use. Often, insecticides and biocontrol don't mix very well because many insecticides are as effective at killing beneficial insects as they are at killing crop pests. However, there are circumstances when insecticides and biological control (and other control tactics) are melded together to form an integrated pest management (IPM) program that reduces insecticide use and is friendlier to human and environmental health. One of the goals of IPM is to reduce the over-reliance on any single pest control tactic in favor of coordinated approaches that are less likely to cause insect resistance and environmental harm. In response to the increasing availability of insecticidal genetically modified (GM) crops as new pest management tools, scientists at the Illinois Natural History Survey (INHS) are developing a framework to assess the potential for GM crops to put beneficial insects at risk. The INHS studies are focused on a familiar native beneficial insect: *Coleomegilla maculata*, or the 12-spotted ladybeetle (this is not the ladybeetle that hangs out in your house during the winter—that is another article altogether!). If GM crops are compatible with biocontrol, then the combination of control tactics will mean that even less pesticide will be needed to control insect pests.

The beneficial and native 12-spotted ladybeetle about to feed on an aphid. Photo courtesy of Jon Lundgren, INHS Center for Economic Entomology

Genetically modified crops, such as corn and cotton, express genes coding for insecticidal proteins from a bacterium named *Bacillus thuringiensis* (*Bt*) to control specific insect pests. These *Bt* crops are effective at reducing insect damage and, according to biotech industry proponents, are virtually harmless to human health, unlike many conventional insecticides. A hotly debated question related to GM crops is whether they are equally harmless to beneficial insects. *Bt* insecticidal proteins specialize at killing specific groups of insects, and so potentially they could be less harmful to insect communities than broad-spectrum insecticides. Also, *Bt*, when sprayed as an insecticide, quickly degrades in the environment and exposure times are limited. However, when genes from *Bt* are expressed in GM crops, the insecticidal proteins can persist in plant tissues for an entire season, increasing the opportunity for biocontrol agents, like the 12-spotted ladybeetle, to be exposed to GM plant tissues.

The 12-spotted ladybeetle is one of the most abundant predatory insects in Illinois cornfields, and is an important predator of aphids and the eggs of the corn earworm and the European corn borer. In addition to feeding on pests of GM plants, this predator is also exposed to the insecticidal protein directly when it eats corn pollen from the GM plants that contain the insecticidal *Bt* protein. Because the 12-spotted ladybeetle acts as a predator and also feeds on GM pollen, it is exposed to the insecticidal protein by two routes.

The INHS research has revealed that the distinct *Bt* insecticides expressed by different GM corn hybrids affect the survival of the 12-spotted ladybeetle differently. For example, pollen from GM corn hybrids currently used to resist damage from the European corn borer and the corn rootworm does not hurt 12-spotted ladybeetles when they eat it. However, the pollen from one unregistered hybrid was found to kill a majority of ladybeetles that fed on it, and could have serious consequences for biological control if it were ever commercialized. In addition to testing the toxicity of different insecticidal GM corn hybrids to ladybeetles in the laboratory, INHS scientists are trying to measure the amounts of pollen (and insecticidal protein) actually ingested by the 12-spotted ladybeetle in Illinois cornfields.

To date, the GM corn varieties planted in Illinois appear to be safe for the 12-spotted ladybeetle, and could be used in conjunction with biocontrol as a component of IPM programs to manage corn insect pests. Nevertheless, as new GM crop hybrids bearing different insecticidal properties are introduced and move toward federal registration, careful screening for unintended effects on beneficial predatory insects must continue. Using research methods developed at the INHS, federal regulators will more effectively address the risk that new GM crop hybrids pose to biological control agents and the environment we all share.

Jonathan G. Lundgren, Center for Economic Entomology

Measuring the Precision of Volunteer Stream Monitoring Methods

The Critical Trends Assessment Project (CTAP) provides an assessment of the Illinois environment using biological data collected by both volunteers and professional researchers. The volunteer component of CTAP is called the Illinois EcoWatch Network and encompasses monitoring of streams, forests, and prairies. RiverWatch (RW) is the largest program within the EcoWatch Network. More than 1,500 dedicated RW volunteers monitor over 200 streams annually. Many volunteer programs, including RW, survey aquatic macroinvertebrates. These organisms are visible to the naked eye and have no backbones. Examples of such organisms include mayflies and snails. These organisms display varying tolerances to pollution, making them ideal candidates for gauging trends in stream quality over time.

RW developed its monitoring design before any national protocols were developed. By 1997, when the U.S. Environmental Protection Agency published its first volunteer stream-monitoring protocols, RW already had over three years of data. RW methods do vary from those of U.S. EPA, making it important to assess the accuracy and precision of its methods. RW data accuracy was addressed in Dr. R.E. DeWalt's study, *Congruence of RiverWatch and CTAP Stream Biomonitoring Data*, comparing volunteer data with those of the CTAP biologists (1999). However, until now, RW method precision has not been examined.

The EcoWatch Quality Assurance (QA) Officer, Alice Brandon, enlisted over 30 volunteers from 16 sites for participation in this study. For the study, volunteers and the QA Officer collected duplicate samples from the same stream site for comparison with one another. Metrics used by RW to measure stream quality were derived for both samples (QA and volunteer) and compared using correlation and descriptive statistics.

RiverWatch volunteers meaure a stream. Photo courtesy of Judy Fitchett, The Conservation Foundation

There was a positive, significant correlation between volunteer and QA Officer data for five of six metrics used to assess stream condition, including taxa richness, % worm taxa, % EPT taxa, EPT taxa richness, taxa dominance, and the Macroinvertebrate Biotic Index. Results for EPT taxa richness were particularly positive with high correlation detected. EPT measures the number of stonefly, mayfly, and caddisfly taxa in a sample. These taxa are typically sensitive to pollution in their environment. Traditionally, RW has used the % composition of EPT in a sample rather than EPT taxa richness. However, this study along with DeWalt's results indicate that using EPT taxa richness instead has some advantages. For example, hydropsychid caddisflies are often highly abundant in degraded streams (DeWalt 1999). Therefore, having high percentages of these pollution-tolerant EPT taxa and concluding "good" stream health is not necessarily accurate. In contrast, EPT taxa richness will not be skewed by abundances of pollution-tolerant EPT taxa.

Mean taxa dominance (percent of the sample comprising the three most abundant taxa) varied by approximately 9% between volunteer and QA Officer samples and there was no statistically significant correlation. This resulted in the two groups rating streams differently using this metric. The study also found sample abundance to vary widely between the QA Officer and the volunteers. This was not of great concern since RW does not use sample abundance to measure stream quality; but, it appears to have repercussions for using taxa dominance since this metric is derived from sample abundance.

Results supported the use of RW methods even though they vary from those espoused by the U.S. EPA. However, there is always room for improvement. Staff are aware of the issue of low sample abundance and there has been much discussion concerning what to do about it. Currently, data from samples with abundances of < 25 organisms are discarded. It may be time to revisit this issue and consider options for increasing the number of organisms collected, which may be as simple as having volunteers sample three rather than two habitats as currently instructed.

Volunteers are doing a good job of following monitoring procedures as indicated by this study. Results here support the assertion that RW methods have a reliable measure of precision, making the data useful for collecting basic information on streams.

For more information on RW metrics and results from this or Dr. DeWalt's report, please access the EcoWatch Web site at: http://dnr.state.il.us/orep/ecowatch/

Alice Brandon, EcoWatch Quality Assurance Officer

Species Spotlight

Mantispid

Susan Post

My front legs resemble a preying mantis, my prothorax a giraffe, my wings a green lacewing, and my larvae have never met a spider egg sac they didn't like. What am I?

Does this seem like some bizarre creature from the land of Dr. Seuss or a real insect? The answer is—a mantispid from the insect order Neuroptera, family Mantispidae, and subfamily Mantispinae.

Mantispa uhleri. Photo by Michael Jeffords, INHS Office of the Chief

Mantispids, or false mantids, resemble miniature preying mantids. Their two front legs are enlarged, equipped with spines, and are raptorial (folded) just like the mantis. In a recent nature center newsletter, a lengthy article was devoted to the preying mantis only to show a photo of a mantispid! Even early taxonomists confused the two as they described new species of mantispids as mantids. The mantispid/preying mantis confusion is an example of convergent evolution, e.g., insects that are not closely related but have evolved similar adult structures due to similar selective pressures.

While the two species may have similar front legs, they differ in their wing structure, size, and life cycle. Mantispids have two pairs of membranous wings crisscrossed by a network of nervelike veins that they hold tentlike over the body. The Order name "Neuroptera" is Greek and means "nerve wing." Mantids, on the other hand, have forewings that are leathery in appearance and the hind wings are folded underneath the forewings. Both sets lie flat on the insect's body. Mantispids are small, 20–35 mm, while preying manitids are larger, 70–120 mm. Perhaps the greatest difference is in their life cycle. Mantispids undergo complete metamorphosis—egg, larva, pupa, and adult—while a mantis has incomplete metamorphosis—egg, nymph (that looks like a miniature adult), and adult.

Climaciella sp. Photo by Michael Jeffords, INHS Office of the Chief

A female mantispid will lay numerous stalked eggs randomly on leaves and wooden structures. The newly hatched larvae, less than a millimeter in size, are very active and begin the search for spiders. They find their spider hosts via one of two ways. Either they actively seek a previously constructed spider egg sac that they enter through direct penetration, or they climb onto a female spider and enter the egg sac as the female builds it. While the mantispid is waiting for the female spider to build an egg sac, it will enter the spider's book lungs and feed on the spider's blood. The mantispids will not molt until they enter an egg sac. If the larva happens to board a male instead of a female, it will eventually die or it can transfer to the female during mating. The mantispid will enter the egg sac before the female spider can finish spinning the silken protective case. Once in the egg sac, the mantispid will dine on spider eggs and undergo three molts. After two to three weeks, the mantispid spins a cocoon inside the egg case and emerges as an adult one to two weeks later.

Manitspa viridis. Photo by Michael Jeffords, INHS Office of the Chief

There are 300 species of mantispids worldwide, with approximately 10 species found in North America. In Illinois, they are generally found in weedy fields, brushy areas, and woodland openings and are usually ignored by the casual observer. The next time you think you've found a miniature preying mantis, take a closer look, it could just be the strange but equally fascinating mantispid.

The Naturalist's Apprentice

Insect Adaptations

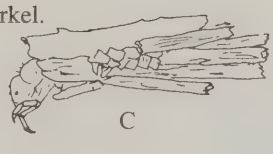
Carolyn Nixon

Insects are the most adaptable group of animals on earth. They are adapted to almost every type of habitat, and there are more species of insects than all other types of animals combined. Look at the pictures shown to the right and below and see if you can match them with the behaviors described on the left.

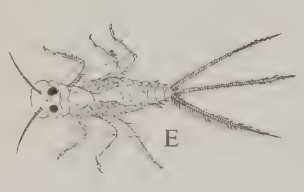
1. I hop.
2. I'm a predator that grasps its prey.
3. I burrow in the ground.
4. I sit in vegetation under the water, but breath air from a snorkel.
5. I swim through the water, much like a rowboat.
6. I have a soft body, so I build a protective case.
7. I drill a hole into wood to lay my eggs.
8. I lay flat against the surface of rocks under water.
9. I bury my body at the bottom of a pit in the sand and capture insects that fall into my jaws.
10. I drink nectar from deep-throated flowers.
11. I swim on the surface of the water and have eyes that see both above and below the water.


A


B


C


D


E


F


H


K


J


G


I

Additional activities:

1. Closely examine several different insect specimens and see if you can determine how they live.
2. Invent a new insect. Draw it to show its adaptations to its habitat and the way it makes a living. (For example, what would an insect look like that lived on the surface of hard ground frequented by herds of bison, and it made its living by capturing crawling insects?)

Answers: 1) D–grasshopper; 2) I–praying mantis or J–water scorpion; 3) G–mole cricket; 4) J–water scorpion; 5) B–back swimmer; 6) C–caddisfly larva; 7) F–horntail; 8) E–mayfly nymph; 9) A–antlion nymph; 10) H–sphinx moth; 11) K–whirligig beetle

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Oaks

continued from front page

springs and recorded how many surviving acorns had germinated by the end of April. We revisited each plot in September to count oak seedlings that had survived the summer. In addition, we counted natural acorn fall, trapped small mammals, searched for squirrel nests, and recorded winter browsing by deer at each site to provide background ecological data.

We found that mammals had a compensatory effect on survival of acorns on the soil surface, with nearly all acorns being removed from all plots where deer, squirrels, or mice had access. More buried acorns survived when squirrels were excluded, probably due to a poorer ability of mice to exploit buried acorns. In addition, buried acorns showed a much higher rate of germination than acorns on the surface, demonstrating the importance of mammal caching behavior on seedling production. As a result, possibly combined with herbivory by deer during the spring and summer, almost no seedlings were recruited on plots where squirrels and deer had access, whereas 3–12 seedlings were recruited to each of our total-exclusion plots in the following fall.

Two interesting observations were made as well. First, in fall 2001, acorn production was moderate, whereas very few acorns were produced naturally at our sites in 2002. Survival of buried acorns was high in our "mouse only" plots in 2001, but mice must have foraged for buried acorns more intensively in 2002, as survival of buried acorns on many of those same plots was much lower that year. Thus, annual variation in acorn production likely has a strong influence on acorn survival, as predicted by many explanations of why oaks show "masting cycles." Second, exploitation of buried acorns by squirrels was lower on several of our plots at Allerton Park and the VRO than at Hart Woods and Brownfield Woods in 2001. The latter two sites are smaller forest fragments and seemed to us to have higher densities of tree squirrels. In future studies, we plan to examine selective herbivory by deer, quantifying their preference for and impact on oak seedlings. For now, our preliminary experiments suggest that high levels of acorn consumption may compound the effects of fire suppression and deer herbivory on oak regeneration. As oaks become less abundant in the canopy of hardwood forests, seed limitation will become increasingly pronounced, especially if some consumers such as deer remain at high densities through years of low and high mast production.

Edward J. Heske and Jared P. Haas,
Center for Wildlife Ecology

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ILLINOIS NATURAL HISTORY SURVEY

Reports

NATURAL HISTORY SURVEY

Spring 2004
No. 379

INSIDE

Prospects for Biological Control of Teasel in Illinois

Some plants that arrive in Illinois from exotic homes lack natural enemies to keep their populations in check and become invasive. The teasel species (*Dipsacus fullonum* [common teasel] and *D. laciniatus* [cutleafed teasel]) are examples of such exotic plants. These Old World plants have been in North America since the 1800s and in Illinois for a number of years. The first records of *D. fullonum* (referred to as *D. sylvestris*) in the Illinois Natural History Survey (INHS) Herbarium date to 1934, but teasel recently has become more visible along roadsides, pastures, and untilled lands.

Mowing is considered to be one of the primary means of spreading teasel, and changes in mowing patterns may be responsible for the increased visibility. Teasel species are monocarpic perennials, meaning they only flower and set seed once. Unlike true biennials, a teasel can remain as a rosette for many years, until it reaches a size at which it bolts, flowers, and sets seed. Continual mowing likely had kept teasel plants small enough that they didn't bolt; fewer mowings (and occurring later in the season) have led to explosions of populations of the plant at many sites, giving the appearance that it recently had arrived. Methods for fighting teasel have included cutting and herbiciding, but costs of labor and chemicals, as well as harm to nontarget plants from overspray, have resulted in reduced effectiveness of these methods. Biological control is one of the few remaining approaches possible.

Staff from the INHS Center for Ecological Entomology have developed a partnership with scientists at the USDA-ARS European Biological Control Laboratory near Montpellier, France, Millikin University, and the USDA-ARS Invasive Weeds Research Unit on the University of Illinois Urbana-Champaign campus. This partnership will, among other activities, search for natural enemies of teasel in its native range. Exploration by USDA scientists in southeastern Europe, southwestern Asia, and France has already uncovered a few potential arthropod agents that may prove useful in the fight against teasel. To date, a flea beetle (*Longitarsus strigicollis*), a leaf beetle (*Galerucea pomonae*), two leafrolling tortricid moths (*Cochylis roseana* and *Endothenia gentianaeana*), a nymphalid moth (*Euphydryas aurenia*), and an unidentified eriophyid mite have been found. Further exploration in Turkey, Greece, and Bulgaria is planned for the summer of 2004.

Brian Rector of the USDA-ARS European Biological Control Laboratory is dwarfed by a teasel in Greece. Photo by Rene Sforza, USDA-ARS European Biological Control Laboratory, Montpellier, France

Teasel offers a unique opportunity for biological control. All species in the teasel plant

Continued on back page

Highlights of the Long Term Resource Monitoring Program at the INHS Great Rivers Field Station

The Illinois Natural History Survey Great Rivers Field Station is one of six field stations that collect data on the Upper Mississippi River System for the Long Term Resource Monitoring Program (LTRMP). In the Water Resources Development Acts of 1986 and 1999 (Public Law 99-662), the U.S. Congress recognized the national significance of the Upper Mississippi River System (UMRS) as both an ecosystem and a transportation system. To ensure that river managers would have access to the scientific information needed to maintain the UMRS as a viable, multiple-use ecosystem, Congress authorized the LTRMP as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is administered through the U.S. Geological Survey in cooperation with the five UMRS states: Minnesota, Wisconsin, Iowa, Illinois, and Missouri. Through this program, researchers at the Great Rivers Field Station have monitored water quality, fish, macroinvertebrates, and aquatic vegetation communities in Pool 26, a 41-mile reach of the Mississippi River above Melvin Price Lock and Dam 26, and 10 miles of the lower Illinois River, for over 10 years (Fig. 1).

Figure 1. Map of the Upper Mississippi River System showing the six LTRMP regional trend areas, including Pool 26. The Illinois Natural History Survey operates two field stations conducting LTRMP monitoring: the Great Rivers Field Station and the Illinois River Biological Station on the La Grange Reach of the Illinois River.

Pool 26 provides important resources to nearby cities and towns in Illinois and Missouri. The Illinois Department of Natural Resources Critical Trends Assessment Program estimated that outdoors enthusiasts in the Pool 26 area purchase approximately 3.9% of all fishing licenses and 6.1% of all hunting licenses issued in the state of Illinois. Based on these license sales and expenditure data from the annual National Survey of Hunting, Fishing, and Outdoor Recreation published by the U.S. Fish and Wildlife Service, we estimate that hunters and fishers expend about $50 million each year in the Pool 26 area (Illinois only). Fish populations in the UMRS also are a resource for commercial fishers, with an average of 780,000 pounds of fish harvested each year from Pool 26 (data source: Rob Maher, Illinois Department of Natural Resources). Data from the LTRMP fish component can provide managers with important information on the status and trends of fish populations in this reach of the Upper Mississippi River, allowing for sound management of this valuable resource.

Fishery-independent data from LTRMP can be directly compared to commercial catch data. Because effort is accounted for in LTRMP data, trends in these data should reflect actual population trends, whereas commercial catch data do not account for effort and can vary with the market value of fish. For several species, including channel catfish and common carp, trends in LTRMP data and commercial catch are similar (Fig. 2). When trends in commercial catch data do not correspond to trends in LTRMP data, this can be a cause for concern, especially when commercial catch remains constant or increases at the same time that LTRMP trends are declining. This is the case for buffalo (*Ictiobus* spp.) in Pool 26 (Fig. 2), so it will be important to continue monitoring the abundance of these species.

Because LTRMP data have been collected consistently for over 10 years, important insights into population and community dynamics of fishes can be gained by examining responses to significant events within the time series. The Great Flood of 1993, perhaps the most important event in this time series, allowed greater access of fishes to the floodplain, which can provide important reproduc-

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tive and nursery habitats. By comparing the abundance of age-1 fish (based on length) in 1994 with all other years, we can look for evidence of increased reproductive success associated with the 1993 flood. Several fishes appear to have produced exceptionally strong year classes in 1993, including common carp, largemouth bass, and black crappie (Fig. 3). Further insights can be gained by following the fate of these year classes. For example, despite the 1993 year class, the overall abundance of most centrarchids (e.g., largemouth bass, bluegill, and crappie) declined for several years after 1993. We hope to identify environmental factors and ecological mechanisms with the potential to explain observed variation in fish communities by further analysis of LTRMP fish, water quality, and aquatic vegetation data.

John H. Chick, Eric J. Gittinger and Eric N. Ratcliff, Center for Aquatic Ecology and Conservation

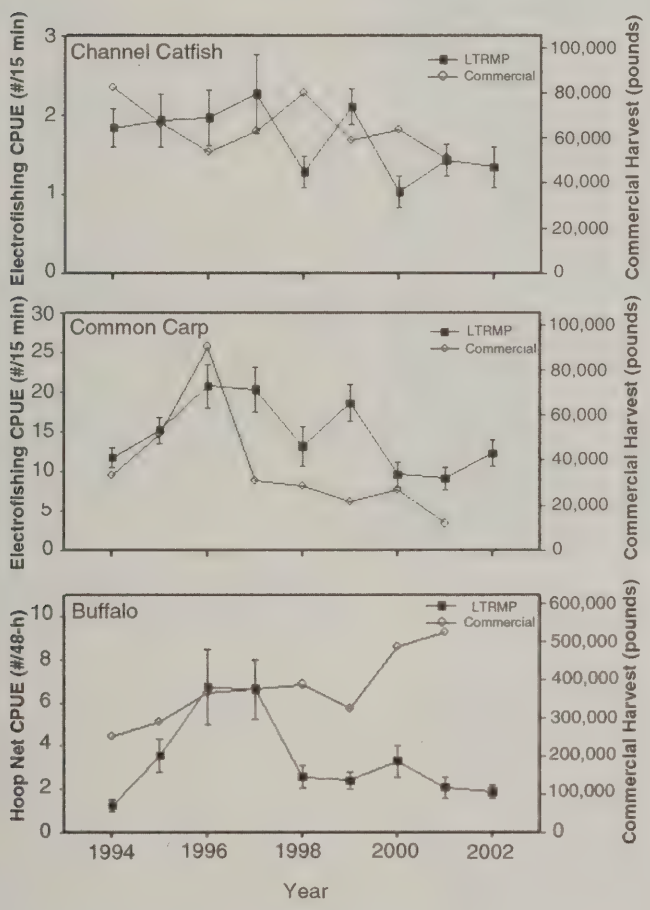

Figure 2. Comparison of LTRMP data and commercial fishing harvest for channel catfish, common carp, and buffalo (*Ictiobus* spp.) in Pool 26 of the Upper Mississippi River.

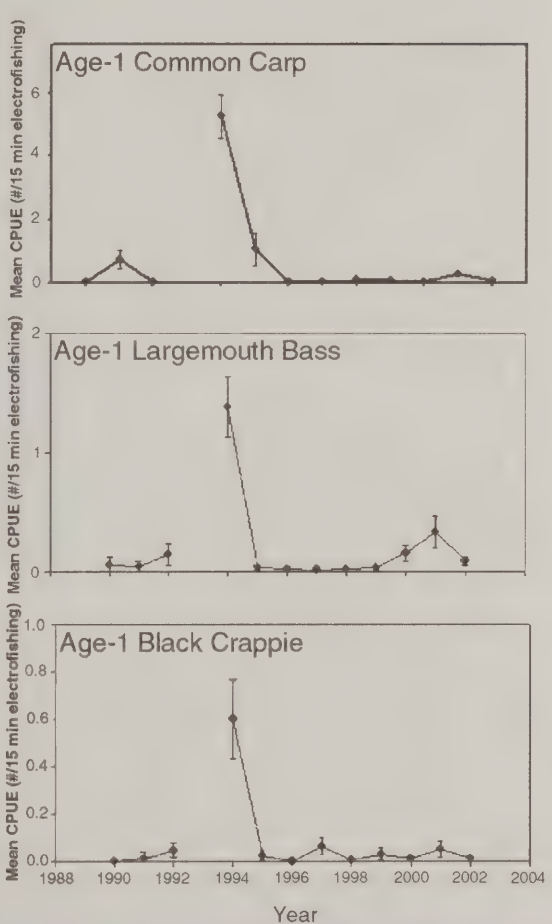

Figure 3. Abundance of age-1 (age estimated based on length) common carp, largemouth bass, and black crappie from LTRMP data collected in Pool 26 of the Upper Mississippi River.

INHS Researcher Named a Fellow by The Wildlife Society

Dr. Stephen P. Havera, Director of the Forbes Biological Station and the Frank C. Bellrose Waterfowl Research Center of the Illinois Natural History Survey, has been honored by The Wildlife Society (TWS) by being named a Fellow at the Society's annual conference in Burlington, Vermont. Dr. Havera was the first North Central Section recipient of the Fellow Award. The TWS Fellows program recognizes society members who have distinguished themselves through exceptional service to their profession. Fellows are appointed for life.

The Wildlife Society, founded in 1937, is the association of professionals dedicated to excellence in wildlife stewardship through science and education. It works to develop and maintain professional standards, advance professional stewardship of wildlife and its habitats, and increase public awareness and appreciation of wildlife management. It has thousands of members in more than 60 countries.

Dr. Havera, a TWS-Certified Wildlife Biologist and a 30-year member of the society, has over three decades of research experience with the Illinois Natural History Survey and has attained the highest rank of Senior Professional Scientist. His research interests include waterfowl, forest wildlife, mammalogy, ornithology, wetlands, and physiological ecology. He has been involved with a variety of conservation issues at the local, state, and national levels via The Wildlife Society, especially in promoting the use of nontoxic shot and strong conservation provisions in the Farm Bills. His work for TWS has included service as President of the Illinois chapter and Treasurer and President of the North Central Section.

His published works include 4 book chapters, 2 books, some 70 technical publications, and 60 reports. He received The Wildlife Society's 2000 Publications Award for Outstanding Book, for *Waterfowl of Illinois: Status and Management* and its accompanying *Abbreviated Field Guide*.

Dr. Havera received his B.S. in biology from Bradley University in Peoria, and M.S. and Ph.D. degrees in zoology from the University of Illinois, Urbana-Champaign. He served in the U.S. Army Military Police from 1968–1970. Havera lives with his wife Nancy and sons Steve and David near Lewistown.

Other recognition and awards include:

• Merit Award for co-chairing Planning Committee for the Governor's Conferences on the Management of the Illinois River System, February 26, 2004.

• Ducks Unlimited's 2004 Conservation Achievement Award in the Technical Category.

• The first Stephen A. Forbes Award for Exceptional Achievement, 2002, Illinois Natural History Survey.

• 2002 Golden Glow Public Servant Award, Association of Great Lakes Outdoor Writers.

• Distinguished Alumnus Award, 2001, College of Liberal Arts and Sciences, Bradley University.

• The Centurion Award for alumni with significant professional career achievements, 2001, Bradley University.

• The Upper Mississippi River Great Lakes Region Joint Venture 2000 Professional Award.

• President, 1994–95, Organization of Biological Field Stations

• Board of Directors, 1993–1994, American Institute of Biological Sciences.

• Member of several other professional organizations and committees including the Mississippi Flyway Technical Section.

• He was an organizational leader in the establishment of the U.S. Fish and Wildlife Service's Emiquon National Wildlife Refuge in Fulton County, Illinois, 1993.

Compiled by Katie Roat, Center for Wildlife and Plant Ecology

Channelization, a Major Factor Influencing Stream Condition in Illinois

Central Illinois was not always high and dry with tidy fields and arrow-straight ditches. During presettlement times this area was covered in native tallgrass prairie, a community promoted by fire. Along larger streams, because they provided firebrakes, a wooded riparian zone formed. This geologically young, prairie landform was poorly drained, a direct result of glaciation that scraped and filled extensive areas as recently as 10,000 to 15,000 years ago.

Despite the wet conditions, the soil was black, fertile, and attractive to farmers. To improve drainage, farmers straightened existing streams and shortening their length. In some cases, they created additional streams where none had existed, through ditching. In addition to creating ditches, farmers also tiled their fields, lowering the water table. Organization of farmers into cooperative, local drainage districts, with the power to levee taxes on landowners within a drainage, and the advent of powerful machinery have been effective at drastically changing drainage patterns. While these practices have allowed for a vast agricultural economy, they also have wrought negative consequences. Because of field tiling, stream channels now fill rapidly after rains and straightened stream channels carry this flow downstream causing erosion, flooding, and scouring of the streambed. The lowering of the water table contributes to low flows and algae-choked channels by late summer. The removal of trees from larger streams and the reduced groundwater flow in summer cause great fluctuations in stream temperature and losses of fauna needing cooler waters.

The Critical Trends Assessment Program (CTAP) (see http://ctap.inhs.uiuc.edu for details of this program) has been sampling Illinois streams at random locations. This design ensures that streams will be represented in the size and quality in which they occur statewide. This effort will help to assess the condition of both natural meandering streams and channelized ones, providing a clearer picture of how agricultural practices affect stream condition.

CTAP assesses stream condition using a Habitat Quality Index, the Hilsenhoff Biotic Index (HBI), and the EPT taxonomic richness (number of species of Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]). The Habitat Quality Index estimates the potential for aquatic organisms to have suitable habitat in which to feed, hide, and reproduce in streams. It also assesses the ability of streamside vegetation to stabilize banks and trap nutrients. Habitat Quality Index values range from 0 to 180, with greater values indicating better habitat quality. EPT taxonomic richness is one of the most efficient biological indices of stream condition and corresponds well to more costly measures of ecosystem function. The HBI is a weighted average of the organic pollution tolerance of aquatic insects. Most EPT taxa in the region have been assigned tolerance values that range from 0 to 10; therefore, a site value may range from 0 to 10, with higher values indicating poorer condition.

Results presented here are from 149 sites sampled over a five-year period beginning in 1997. Sites were categorized as channelized or meandering, were regionalized by which of 10 Illinois Streams Information System (ISIS) basins they came from, and by stream width code (Code 1 = 1–2 m wetted width, width code 5 =>30 m). Additionally, an Overall Index, based on statewide percentiles for EPT, Habitat, and HBI was calculated for each site using the following equation:

Overall %ile = (EPT %ile * 0.4) + (HBI %ile * 0.2) + (Habitat %ile * 0.4)

HBI is not as sensitive to degradation of stream condition as EPT or Habitat; hence, its influence on the score has been reduced. Qualitative ratings (excellent, good, etc.) were constructed for each site based on the Overall Index (Table 1). Analysis of Variance was used to examine the effects of channelization, stream size, and ISIS basin on EPT, Habitat, HBI, and Overall Index.

RESULTS

EPT taxonomic richness was most affected by channelization. Streams with meandering channels produced an average of 11.8 EPT (n=88), while channelized streams produced 7.1 (n=61) taxa. This is a 40% difference! Stream width was also an important factor, with larger streams supporting more EPT taxa (Fig. 1). ISIS basin appeared not to be a significant fac-

Table 1. Percentile ranges and tentative quality ratings for stream ecological indicators.

Percentile Ranking for Ecological Indicators	Tentative Quality Rating
≥90	Excellent
≥75 to <90	Good
≥50 to <75	Fair
≥30 to <50	Poor
<30	Very Poor

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Channelization

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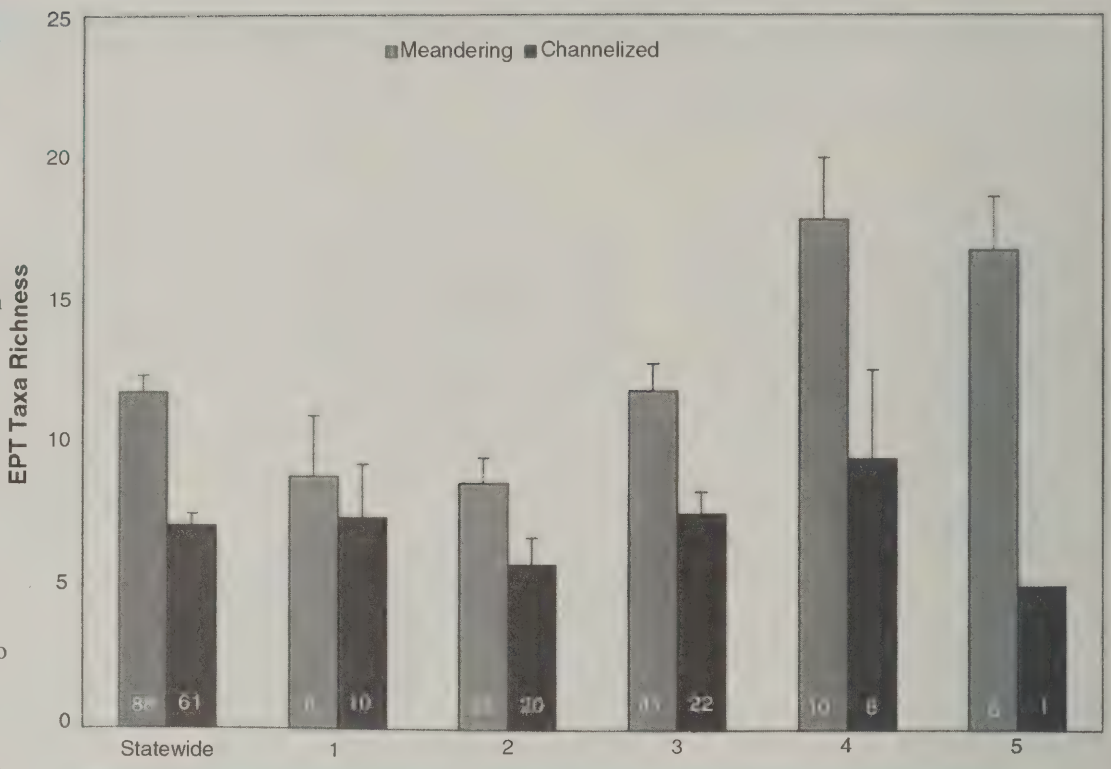

Figure 1. Mean EPT taxonomic richness + standard error for meandering and channelized streams statewide and for five stream width codes (increasing integer = increasing stream width). Numbers in bars indicate sample size. Statewide, channel types were statistically distinct as were widths 1, 2, and 3 and widths 4 and 5.

tor on its own, but an interaction between basin and stream width was detected. This complicates the picture somewhat, as it appears that some basins did not display an increase in EPT richness with increasing stream width. HBI, calculated from the EPT community, did not vary significantly in relation to the three factors. Most often, values were between five and six units. However, sites with much lower values were found in the Shawnee Hills of southern Illinois with a mean of 3.5 (n=5). It appeared that this index only has value in isolated areas across the state and in the Shawnee Hills in particular.

Habitat quality was heavily affected by channelization, with meandering streams scoring significantly higher (107.6 points) than channelized streams (70.9 points). While ISIS basin was not an important factor alone, it did interact with channelization to produce a significant result (Fig. 2). The Rock River and Spoon River basins appeared to have no significant differences in habitat quality for the two channel types, whereas significant differences existed in the other basins. These basins had the lowest habitat scores for meandering streams; hence, it may be that meandering streams in this region are too heavily impacted to demonstrate differences with channelized ones.

Overall Index values varied significantly with channelization, with meandering streams scoring an average 61.8% (fair quality from Table 1) and channelized streams scoring only 35.8% (poor quality). Neither ISIS basin nor width alone was a significant factor explaining Overall Index; however, a significant interaction between basin and width was noted. It appeared that Overall Index values (condition) improved with stream size, except in the Big Muddy, Little Wabash, and Rock basins. It appears that the smallest streams were the most heavily degraded in large agricultural drainages (Sangamon, Kankakee/ Vermilion/ Mackinaw) and in an urbanized one (Fox/ Des Plaines).

DISCUSSION

Because this sampling program was based on randomly selected sites, it is assumed that they are representative of the state as a whole and that inference about the quality of other streams, and the frequency in which they occur, may be drawn from this sample. Based on overall percentile scores, 45% of streams sampled by this program were rated as "poor" or "very poor" (Fig. 3). Some of the worst offenders (Overall Index < 10%) had less than two EPT (two had none), were channelized, and had no natural riparian zone. The percentages of fine sediment (sand, silt, and clay fractions combined) usually exceeded 80%, a trait promoted by heavy erosion. These poorest-of-the-poor were not relegated to any one basin, but could be found in any, whether urbanized or agricultural.

The chances of the program finding excellent quality streams were remote, but five (3%) were found that had overall percentile scores ≥90%. These streams supported in excess of 14 EPT taxa, had meandering courses, wide treed riparian zones, and produced some of the lowest HBI values in the state. The greatest proportion of streams with these characteristics can be found in the Shawnee Hills subsection of the Big Muddy basin, but can also be found anywhere in the state. It is imperative that these best sites are characterized, since they set the regional biotic potential for stream condition.

Channel type appeared to be the most important factor determining over-

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Channelization

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all quality (and its components). Vast improvements could be made if this one stream characteristic was focused on in policy and restoration guidance given by state agencies. Re-establishment and widening of natural riparian zones would reduce soil erosion, capture pollutants, reduce algal blooms, and ameliorate water temperatures. Restoration is a long-term endeavor, especially so for sensitive aquatic insects that reside now only in islands of suitable habitat or at the periphery of the state.

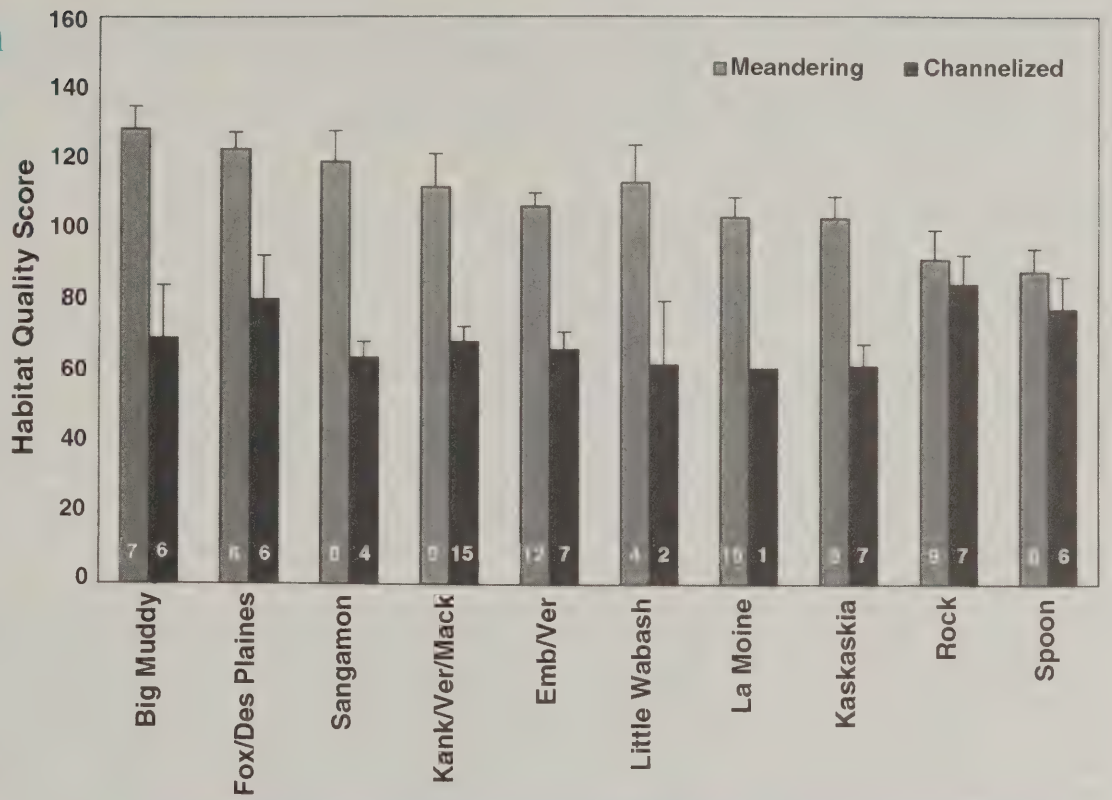


Figure 2. CTAP stream sampling mean Habitat Quality Index score + standard error for ISIS basins by channel type. Numbers in bars indicate sample size. Note that Rock and Spoon basins are similar for both channel types.

Large-scale restorations might require reintroduction of the most sensitive, least vagile species to help bridge geographic gaps between restored habitat and recolonization sources.

Dr. R. Edward DeWalt, Center for Biodiversity Critical Trends Assessment Program

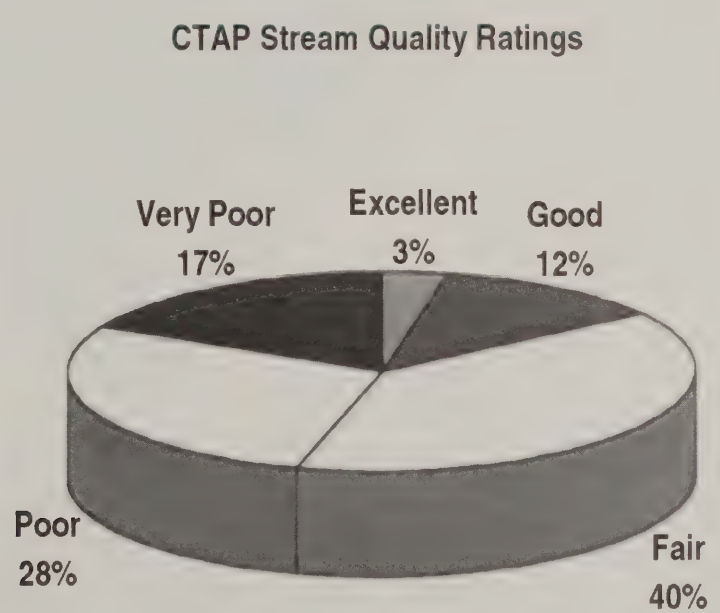


Figure 3. Summary of qualitative stream ratings based on Overall Index values for 149 streams.

Critical Trends Assessment Program Web Page: A Window into Illinois Habitats

The Critical Trends Assessment Program (CTAP) is a long-term endeavor to monitor the condition of forests, wetlands, grasslands, and streams throughout the state of Illinois. Data on plants, birds, and terrestrial and aquatic insects are collected. The main purpose of conducting this monitoring is to assess long-term changes in ecological conditions as well as to develop a baseline from which to compare regional and site-specific patterns throughout Illinois. In 2001, the Illinois Natural History Survey CTAP biologists finished the first five-year cycle of this statewide monitoring program. After collecting data from 1997 through 2001 and putting out written reports, it became clear that a new format was needed to present our data. The Internet provided a perfect tool to accomplish this. The new CTAP Web page (http://ctap.inhs.uiuc.edu/) was created to meet the challenges of promoting the program and presenting statewide data to the people of Illinois.

The CTAP Web page provides a general description of the monitoring program. In addition, it provides links to the main Illinois Department of Natural Resources-CTAP Web page (http://dnr.state.il.us/orep/ctap/) where additional information about the history of the program can be found. Several features are available for the users on our Web site starting with "Monitoring Protocols." This portion of the site gives a general overview of our monitoring protocols. A PDF file with our official protocols is available for downloading. This file gives a detailed explanation of our protocols, including the site selection process, sampling procedures, and datasheets that the program uses. The main purpose of providing such detailed documents is to allow any group to download the information and conduct monitoring across the state using our protocols. The advantages are many since users can query our databases to answer questions related to state and local habitats.

Next, you can find "On-line Data," one of our vehicles of data dissemination. Several unique features are provided. The CTAP Database search engine allows searches by habitat, taxa, and geographical area. These searches are available under "Site Fact Sheets," "Regionalized Fact Sheets," and "Species." Site fact sheets are available for each CTAP study site for plants, birds, and aquatic insects (ETP), and, in the near future, the terrestrial insect data will be available. Each fact sheet has summary information for the site, including ecological indicators, site photos, and a species list. In addition, these site-specific data are compared with statewide averages. Also, you can view a map for each habitat with a hot link to each of these fact sheets.

Beside the CTAP Database search engine, we have summarized the data into tables under the heading "Data Matrix for Professional Scientists Monitoring—Plants, Birds, and EPT" under "On-line Data." These tables can be downloaded as text (i.e., tab delimited) or Excel files. Some fields have been password protected since we want to protect specific site locations. All the data are generated through an Access database. Also under "On-line Data" you will find that we host the EcoWatch data (our sister group) in a similar format as described previously, and we provide the link to the data entry portion of this program (see "Data Input").

In addition to the described features, the CTAP Web page provides other useful resources such as publications. Here you will find all CTAP professional scientists' reports including annual reports and other publications where CTAP data have been used. For example, CTAP—Invasive Plant Species in Illinois Forests is a series of maps showing the distribution of nine invasive species, such as garlic mustard, across the state. In addition, a link to CTAP regional assessments is provided. Our Geographical Information System page is still under development, but will provide links to very useful information such as the map *Land Cover of Illinois in the Early 1800s*. Also, you can find a glossary page that provides explanations for all pertinent scientific or data-related terms. Finally, we have a sign-in feature that allows users to access some protected data on the Web. However, additional data requests, such as the raw data, can be obtained by contacting one of our staff members (see "People").

As new information is gathered during the second cycle of the program (2002–2006), our data will be updated on the Web. Targeting a Web page that will meet the needs of every user is not an easy task. As a program, CTAP has realized the importance of developing a Web page that is easy to navigate and where with the click of a button, reliable information about the state can be found.

Brenda Molano-Flores, INHS CTAP Coordinator

Transmission Cycle of *Neospora caninum*: A Single-cell Parasite at the Interface Between Domestic and Wildlife Species

Neospora caninum is a single-cell parasite recognized worldwide as a major cause of abortion and neonatal mortality in cattle, resulting in substantial economic losses to the cattle industry. Cattle are believed to become infected through the consumption of soil, water, or feed contaminated with canine feces containing *N. caninum* oocysts (the stage of the parasite capable of surviving in the environment). In 1998, domestic dogs were confirmed as definitive hosts of *N. caninum*. That is, in dogs, *N. caninum* can complete its life cycle resulting in the shedding of oocysts in feces. Alternatively, *N. caninum* can only undergo part of its development in intermediate hosts such as cattle, where the parasite remains encysted (encapsulated) in tissues. Dogs and other scavengers may then become infected through the consumption of *Neospora*-infected tissues, such as bovine meat, placenta, or aborted fetuses.

While the domestic cycle of *N. caninum* had been documented, the wildlife (sylvatic) cycle remained unknown. We suspected that wild canids and deer were natural reservoirs for *N. caninum* and that they shared the transmission cycle of the parasite with domestic animals (Fig. 1). During the hunting seasons, abundant offal (resulting from field dressing deer) becomes available for consumption by dogs and wild canids. This creates potential seasonal increases in the risk of *N. caninum* transmission from wild cervids to canids. Seroprevalence and clinical studies in deer had provided indirect evidence that deer may take the place of cattle as intermediate hosts. Likewise, reports of *N. caninum* antibodies in coyotes, dingoes, and red foxes suggested that like domestic dogs, wild canids could play a role in parasite transmission.

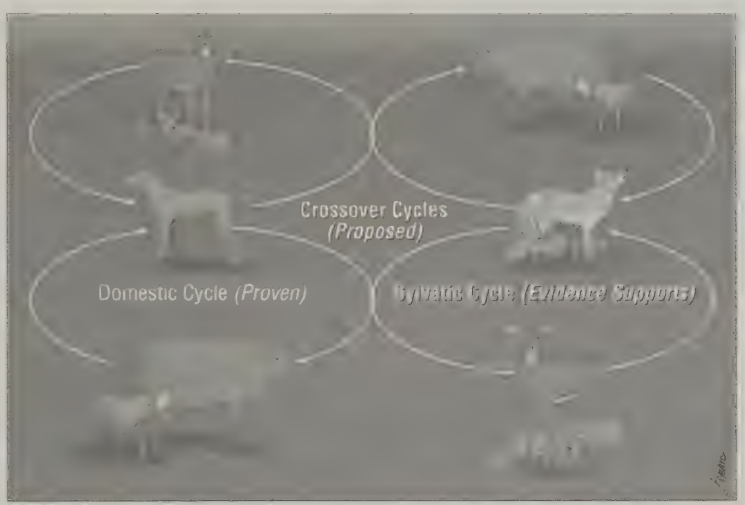


Figure 1. Domestic cycle (proven) and suspected sylvatic cycle of *N. caninum* (now confirmed) as they overlap across species. **Illustration by Kerry Helms, University of Illinois**

We detected seropositivity (antibodies for *N. caninum*) in 16.6% of 42 coyotes sampled in Illinois between 1997 and 1998. On December 2001 during the second firearm deer hunting season in Illinois, we found seropositive test results in 50% of 30 hunter-killed white-tailed deer. Our subsequent serological studies aimed at the detection of antibodies for *N. caninum* in wild animals detected 38.4% of 164 gray wolves, 10.6% of 113 coyotes, 25.9% of 193 white-tailed deer, and 13.1% of 61 moose seropositive for *N caninum*.

These data supported, but did not confirm, the existence of a sylvatic cycle of *N. caninum*. In an effort to gather more information, paired blood samples and brain tissues were collected from deer during the 2001 deer hunting season. Tissue samples from *N. caninum* seropositive deer were fed to dogs which resulted in the shedding of *N. caninum* oocysts, indicating that deer are efficient intermediate hosts of the parasite and are capable of transmitting *N. caninum* to domestic dogs. Recently, coyotes were demonstrated to shed *N. caninum* oocysts after consuming tissues from *N. caninum*-infected cattle. In order to compare the isolated *N. caninum* parasites obtained from deer and from cattle, we sequenced the internal transcribed spacer 1 (ITS1) region of the ribosomal DNA from each isolate, and the results were identical. These findings indicate that *N. caninum* has probably been cycling between domestic and wild animals.

The discovery of new wildlife hosts of *N. caninum* and the ability of the parasite to cycle among domestic and wild animals pose new challenges for the control of neosporosis (disease caused by *N. caninum*). Further investigations are needed to determine the risk of transmission of *N. caninum* between wildlife and domestic livestock, and to compare the efficiency of the sylvatic and the domestic cycle based on number of oocysts shed by the definitive hosts under similar challenges. Additional studies are also needed to understand the impact of neosporosis on wildlife populations. A fatal case of neosporosis in a Californian black-tailed deer and postmortem findings of the parasite in a full-term, still-born deer in France provide evidence that clinical neosporosis in deer might be similar to cattle.

Luis F. Pita Gondim and Milton M. McAllister, University of Illinois; Nohra Mateus-Pinilla, Center for Wildlife and Plant Ecology; William C. Pitt, National Wildlife Research Center, Hilo Field Station, Hilo, Hawaii; David Mech and Michael Nelson, USGS Northern Prairie Wildlife Research Center, Minnesota; Mark S. Lenarz, Minnesota Department of Natural Resources

Species Spotlight

Devil Crayfish

Susan Post

Mudbugs, ditch bugs, river lobsters, crawly bottoms, or crawdads are all common names for crayfish, a group of arthropods that resembles miniature lobsters. Crayfish are common inhabitants of wetlands—from springs to large rivers, damp meadows to swamps and ditches. There are approximately 353 species of crayfish in the U.S. with 95% of them found in the Southeast. Illinois has 21 species of native crayfish.

The devil crayfish (Cambarus diogenes).
Photo by Chris Taylor, Center for Biodiversity

A species found throughout Illinois is the devil crayfish, *Cambarus diogenes*, named after the Greek philosopher Diogenes. They are multicolored, brown to brownish red, green to blue, and are 36 to 48 mm in length. Like all crayfish they have two body regions, a cephalothorax and abdomen. The cephalothorax is the head and thorax fused together and enclosed in a hard outer covering called a carapace. Crayfish breathe through gills that are located under the carapace. Their eyes are on moveable stalks that allow sight in different directions. Five pairs of jointed legs are present on the cephalothorax. The first pair are pincerlike and called chelae. On the last segment of the abdomen is a broad flipper that helps propel the crayfish through the water. By folding their abdomens down and forward, they are also able to swim backwards.

Crayfish are omnivores and will consume whatever food is available. While their primary food is usually decaying and living plant material, they will also consume aquatic worms, insects, snails, and dead animal matter.

The devil crayfish is abundant in the Shawnee Hills and the Coastal Plain of southern Illinois, while it is less common in northern and western Illinois. It is found primarily along streams or in lowland areas having clay soil. It is in these lowlands that colonies often occur with hundreds of chimneys.

The devil crayfish lives in a burrow with a cone-shaped mud chimney. Its burrow can be up to a meter in length and is usually at the side of a stream or pond. The chimney-topped hole leads to an underwater chamber and a second nearly horizontal tunnel leads into the stream. The crayfish does its digging at night. The chimneys are piles of pellets of mud or clay that the crayfish brings up and deposits around the opening of its burrow. These burrows can serve as refuges not only for the crayfish but other organisms. An interesting relationship has developed with the endangered Hines emerald dragonfly and the devil crayfish. The dragonfly's larvae will spend time in these burrows if their primary habitat dries up; however, the crayfish are potential predators of the dragonfly. This relationship is being studied at the Illinois Natural History Survey.

Crayfish leave their burrows either in the fall or late winter-early spring to mate in open water. The females will carry the sperm until oviposition. In Illinois, the devil crayfish will produce eggs from March to May. The female carries the eggs on the short appendages of her abdomen. These abdominal appendages are in constant motion to keep water flowing over the eggs. Females brood the eggs until they are hatched. The newly hatched crayfish hold onto their mother until they molt two or three times. Once the young leave their mother, they seek cover in rocky parts of streams or the marginal vegetation of standing water until they are large enough (about 20 mm in length) to burrow. The young crayfish will become capable of reproducing after they have molted 6–10 times.

Threats to crayfish populations include habitat damage caused by impoundments, stream channelization, pollution, and sedimentation. The biggest threat,however, is nonnative crayfish introduced as fishing bait.

Definitions

jambalaya—an herb-seasoned, southern rice dish often prepared with crayfish, shrimp, or oysters.

etouffee—a crayfish stew, usually served over rice.

Solution

The Naturalist's Apprentice

Crayfish Word Search

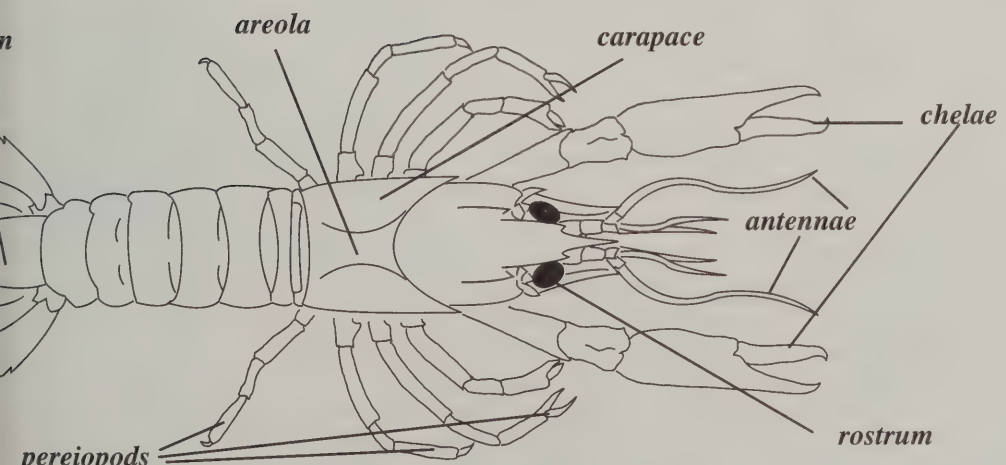
Carolyn Nixon

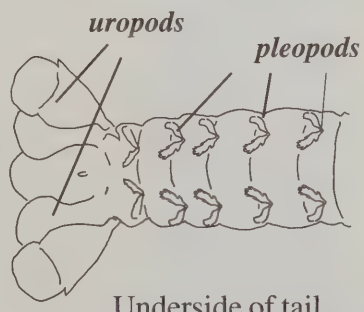
Crayfish Word Search

Below are lists of crayfish names, habitats, anatomy, and recipes that use crayfish as an ingredient. There is also a diagram showing crayfish external anatomy. Search the grid of letters below for these hidden words. The words can be horizontal, vertical, or diagonal and begin from either end (for example, rivers or srevir).

Crayfish names	Crayfish habitats	Crayfish recipes	Crayfish anatomy
decapoda	**rivers**	**jambalaya**	**telson**
crustacean	**marsh**	**etouffee**	**chelae**
crayfish	**streams**		**areola**
crawfish	**swamps**		**pereiopods**
crawdad	**chimneys**		**pleopods**
mud bug	**caves**		**antenna**
			carapace
			uropods
			rostrum

G O D G I L L I E C A P A R A C
Y P L E O P O D S R T C W L T M
S E V A C R A Y F I S H O R R A
P H I L H A L I K I T E L S O N
P E R E I O P O D S R L L A S T
D E K I M S T O S A E A I Y T E
A N T E N N A M D Z A E W A R N
D R O S E C C S W A M P S L U N
W L A D Y O R K Y P S I D A M A
A C R U S T A C E A N K O B S I
R E I R A C W W I G M A P M U T
C M E T O U F F E E I T O A S S
N I X O N R I V E R S B R J A O
L A M A R S H S G U B D U M N P





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Teasel

continued from front page

family (Dipsacaceae) are exotic—there are no native relatives in the family. Thus, when conducting tests to assure specificity of arthropod agents, there are no close relatives to test, meaning the initial assays will be conducted using relatives of teasel from the Old World. Although host specificity of agents is still critical, the lack of close relatives may make the process of finding biological control agents a little easier.

At the same time that the foreign exploration is ongoing, we are studying the ecology of the plant in Illinois habitats. Our studies along Interstate 72 near Decatur and at the Mascoutin State Recreation Area at Clinton Lake have already shown increases in size of teasel patches due to mowing and dispersal of seeds by wind, rather than by vehicular traffic. We currently are looking to determine if any native insects or mites may be feeding on the plant. We also are assessing other control methods, such as the optimal timing of mowing to minimize seed spread and whether combinations of mowing and herbicide use may make the plant more vulnerable to multiple tactics. We hope that these studies will prepare us for the potential introduction of arthropod agents and help us fit biological control into the current management regimens.

Teasel leaf in France shows insect feeding damage caused by its natural enemies. Photo courtesy of USDA-ARS European Biological Control Laboratory, Montpellier, France

Robert Wiedenmann, Center for Ecological Entomology and Judy A.D. Parrish, Millikin University and affiliate of Center for Ecological Entomology

Illinois Natural History Survey Reports is published quarterly by the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the Illinois Department of Natural Resources.

INHS Reports is edited by Tom Rice and Charlie Warwick and printed on recycled and recyclable paper. Design by Otto-Walker Communications.

ILLINOIS NATURAL HISTORY SURVEY

Reports

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Summer 2004
No. 380

INSIDE

From Air to Water Contamination: Steps to Reduce High Sulfur Coal Pollution

In recent years, Illinois has consistently ranked among the top 10 states for both productive capacity and number of coal mines; underground mines are currently more common than surface mines. Illinois coal has a high BTU rating (produces more heat per pound), but because of the environment in which coal beds were formed, it is also relatively high in sulfur. In fact, as of 1997, 94% of Estimated Recoverable Reserves in Illinois fell into the "high sulfur" category. By comparison, only 7.5% of Estimated Recoverable Reserves of Wyoming are considered high in sulfur. The high sulfur content of Illinois coal presents problems for both coal burning power plants and coal processing facilities regarding compliance with environmental regulations enforced under the Clean Air and Clean Water Acts.

Abbott Power Plant at the University of Illinois that burns "scrubbed" high sulfur Illinois coal. **Photo by Charlie Warwick, INHS Office of the Chief**

Upon combustion, sulfur in coal is released to the atmosphere, often in the form of sulfur dioxide, which reacts with water vapor to become sulfuric acid. These reactions are responsible for acid precipitation problems in much of the eastern United States. In an effort to reduce sulfur emissions as required under the Clean Air Act, coal preparation facilities now wash coal prior to combustion. This practice produces a liquid waste, or effluent, that must be released into a nearby receiving stream or river. Essentially, to reduce airborne sulfur emissions at power plants, processing facilities must increase sulfur contents in local watersheds. However, a process similar to the one that transforms combusted sulfur into sulfuric acid (H_2SO_4) in the atmosphere also occurs in freshwater. In order to comply with the Clean Water Act, acidic effluents must be neutralized prior to release, usually by the addition of a base like sodium hydroxide (NaOH). The result is an effluent with neutral pH (~7) containing high concentrations of dissolved sodium (Na^+) and sulfate (SO_4^{2-}). Because of the high concentrations of these dissolved chemicals (or ions), the effluent is more similar to saltwater than freshwater.

It has long been known that freshwater organisms do not function well in the presence of high concentrations of ions (i.e., in salty water). In fact, the first aquatic toxicity experiment is usually credited to the ancient Greek philosopher and scientist, Aristotle, who transferred freshwater fish to seawater to observe the effect. In present times, aquatic ecotoxicologists most often focus their research on contaminants that are toxic at minute concentrations, such as cadmium or dioxins; however, in some situations as described above, ordinarily "nontoxic" ions commonly found in freshwaters at

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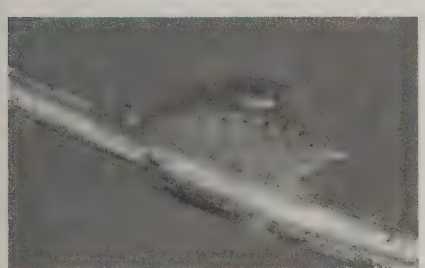


Hyalella azteca, a type of amphipod crustacean that is sensitive to sulfate toxicity in Illinois streams. Photo by Michael Jeffords, INHS Office of the Chief

Fishing Illinois via the Internet

On April 1, 2004, the Illinois Department of Natural Resources (IDNR) announced the launch of a new Web site (www.ifishillinois.org) that provides the public with an array of informative resources about fishing and boating in Illinois waters.

Weekly fishing reports, sport fishing prospects, regulations, and fishing tips are just a few examples of the services provided by www.ifishillinois.org. Information is provided about more than 70 inland lakes, 8 major rivers and streams, and Lake Michigan, making it one of the most comprehensive on-line resources for Illinois fishing available. The Web site also includes a special section called "Kids and Family Fishing," that provides information on hotspots for kids and families, as well as beginner anglers.

The "Kids Fishing Hotspots" includes locations throughout the state, identified by IDNR district fisheries biologists, where children are likely to catch a lot of fish. This section of the Web site provides a printable fishing guide that includes techniques for tying a knot, baiting a hook, as well as other useful information for the young angler. Access to information on how to get a fishing license, as well as a downloadable version of the statewide fishing regulations booklet is also available. Lastly, the section provides a variety of downloadable educational materials with activities for children excited about fishing.

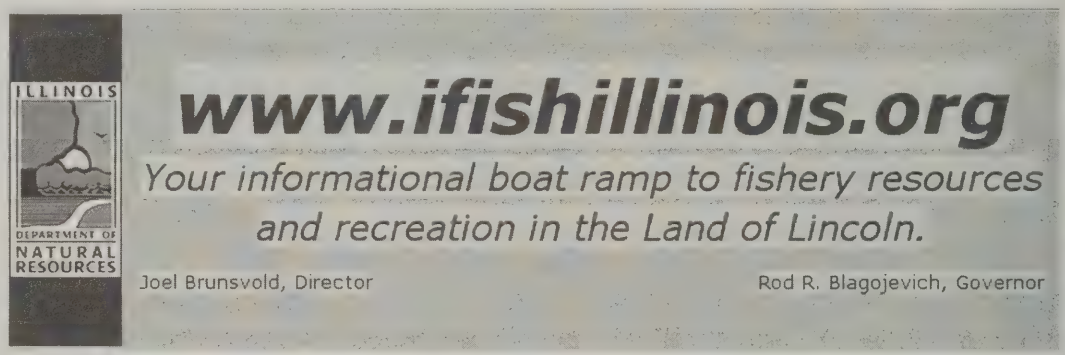
The "Weekly Fishing Reports" section provides anglers with types of fish being caught and bait being used on a selected lake. Each week, IDNR Fisheries personnel submit these fishing reports electronically for lakes around the state, and the Web site is then updated automatically, providing anglers with up-to-the-minute information on fishing conditions. Fisheries biologists also provide fishing prospects information for www.ifishillinois.org, giving the public an easy way to find a local lake with their favorite target species, all on-line.

Users of www.ifishillinois.org can browse over 70 lake profiles that include information lake maps describing habitat types and depth contours, information about on-site public recreational facilities, sport fishing prospects, and annual sport fishing status reports generated by IDNR Fisheries biologists. Major reservoirs (Rend Lake, Carlyle Lake, and Lake Shelbyville) as well as several river systems and Lake Michigan are also profiled on this site. Profiles of major rivers provide information similar to lake profiles, as well as printable fishing guides and canoeing information and maps.

The Web site also features a "Science" section that highlights various fisheries-related studies conducted by Illinois Natural History Survey (INHS) and IDNR personnel, including creel survey reports, fish species profiles, and information about exotic and endangered species. Creel survey data and reports are generated by INHS personnel and continually updated. Analyses of creel data are provided so that both the general public and scientists from other institutions may benefit from INHS efforts to better understand angling and fish populations in Illinois. The "Science" section also profiles several fish studies in progress at INHS.

IDNR's fisheries programs are also highlighted on the Web site, including information on the Tackle Loaner, Urban Fishing, and Hatcheries and Stocking programs. The Urban Fishing program provides detailed information for each region including sites of free fishing clinics. The Access to Fishing and Tackle Loaner programs provide rod and reels for the public to borrow and lists the loaning locations, oftentimes public libraries or local park districts.

Clearly www.ifishillinois.org has much to offer the angling public. E-mail has already been arriving showing interest and pleasure with the site. As with any Web site, material is always being added and modified—more lakes, rivers, and creeks will be added during the upcoming year as well as more scientific information. We encourage readers to visit www.ifishillinois.org frequently, and most importantly, get out there and go fishing!



(www.ifishillinois.org is partially funded by the U.S. Fish & Wildlife Service Sport Fish Restoration Fund)

Thomasine McNamara and Jeff Stein, Center for Aquatic Ecology; Jim Mick and Mike Conlin, IDNR Division of Fisheries

INHS Researcher Named Fellow by American Association for the Advancement of Science

Dr. Robert J. Novak, a Professional Scientist at the Center for Ecological Entomology, Illinois Natural History Survey, was recently elected and named Fellow of the American Association for the Advancement of Science. He was given this honor for his "fundamental biological studies of mosquitoes and for leadership in mosquito control in the United States, Africa, and the Caribbean."

The American Association for the Advancement of Science is the world's largest general scientific society, and publisher of *Science*. AAAS seeks to advance science and innovation throughout the world for the benefit of all people.

A fellow is defined as "a Member whose efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished." Examples of areas in which nominees may have made significant contributions are research; teaching; technology; or administration in academia, industry, government, and other institutions. The honor of being elected a fellow of AAAS began in 1874 and is acknowledged with a certificate and a rosette presented at the Fellows Forum during the Annual AAAS Meeting.

Election as a fellow of AAAS is an honor bestowed upon members by their peers. Fellows are recognized for meritorious efforts to advance science and its applications.

Dr. Novak received a B.S. in biology from the University of Southern Colorado in Pueblo; an M.S. in biology at the University of Utah in Salt Lake City; and a Ph.D. in entomology from the University of Illinois. He then served as an NIH Post-doctoral Fellow in vector biology and parasitology at the University of Notre Dame.

Prior to coming to INHS, Dr. Novak was a Research Entomologist with the U.S. Public Health Service, Centers for Disease Control, Vector-borne Viral Disease Division, in San Juan, Puerto Rico, and CDC's Bureau of Tropical Diseases, in Atlanta, Georgia.

Dr. Novak has contributed consistently to the medical entomology community through his service as Vice President, President-elect, and President of the American Mosquito Control Association, and was awarded the Association's Medal of Honor in 2003. He has been a consultant to numerous organizations and agencies worldwide, including the World Health Organization, Pan American Health Organization, U.S. Agency for International Development, U.S. Fish and Wildlife Agency, and the U.S. Army Medical Virology Institute.

Dr. Novak's published works include more than 70 scientific and technical papers, book chapters and conference proceedings, as well as 2 bibliographies. He has been funded from a variety of sources over his career, including significant funds from the National Institutes for Health, Centers for Disease Control, National Science Foundation, and the Illinois Soybean Board.

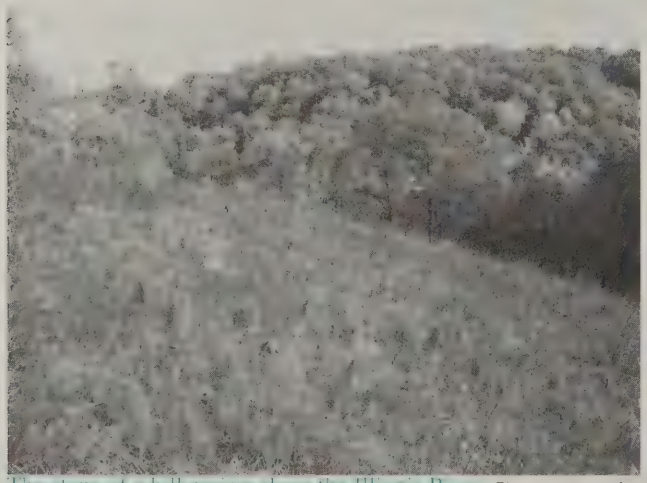
Dr. Novak lives in Champaign with his wife, Loraine, and has two daughters Lisa and Karen.

Compiled by Robert N. Wiedenmann, Center for Ecological Entomology

Hill Prairies Along a Stretch of the Illinois River

Hill prairies were once a common feature of south- to southwest-facing river bluffs in the Tallgrass Prairie Ecoregion from Minnesota and Wisconsin to Missouri. Prior to European settlement, most hill prairies were probably no larger than 1 ha, punctuated by forested ravines. They contained typical tallgrass prairie plant species, species disjunct from the Western Plains, and a few hill prairie endemics. The open prairie structure of these habitats was due to a combination of droughty soils, exposure to dry prevailing winds and sun, and periodic fires. With European settlement, hill prairies were mostly used to graze livestock, rather than for crop production, due to their steep topography. As a consequence, a higher proportion of hill prairie habitat persisted compared to other prairie types. Today, hill prairies are disappearing due to encroachment from adjacent forests and invasive native and exotic bird-dispersed shrubs, as well as extreme erosional disturbances.

In general, the decline in the abundance and sizes of hill prairies is related to the requirement for moderate disturbance to prevent woody encroachment. Woody plants invaded these canopy openings because livestock grazing decreased in the latter half of the 20th century and settlers suppressed natural fires, both of which kept woody species in check. Several researchers have documented area loss rates ranging from 55% to 72% on average at high-quality sites over intervals of 30–40 years.



The slope of a hill prairie along the Illinois River. Photo courtesy of Adrienne Edwards, INHS Center for Wildlife and Plant Ecology

Given the decline in the sizes and abundance of hill prairies in Illinois, we are examining the question, "To what extent do species diversity within hill prairies or species presence surrounding hill prairies correlate with hill prairie quality, size, or degree of isolation within a small landscape?" We focused on 21 small (< 0.5 ha) gravel hill prairies parallel to a 33-km stretch of the west bank of the Illinois River in Marshall and Bureau counties. Plant species composition and relative abundances were recorded periodically throughout the growing season (April – October 2002), and the resulting species lists were subjected to Floristic Quality Assessment. Woody species present around the perimeter of each prairie were also recorded. GPS readings were taken around the circumference of each prairie. GPS data were used to determine the area and perimeter-to-area ratio of each prairie opening, and to develop a distance matrix among prairies.

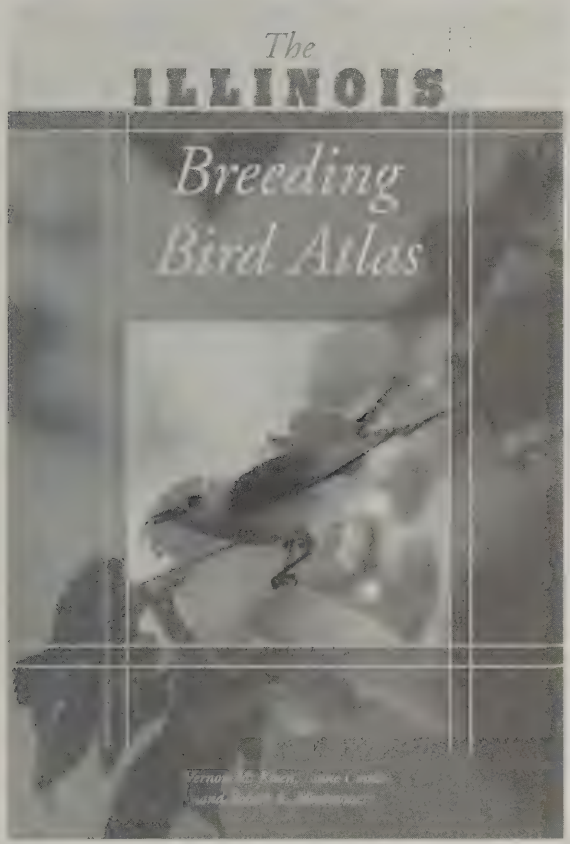
A first step in our analyses was to describe differences in species composition and characteristics of the prairie openings. We report a few of those findings here. Each prairie opening averaged 66 species (from 42 to 92), with 1 to 10 non-native species. Overall, mean Coefficients of Conservatism and Floristic Quality Indices ranged from fair to relatively high (3.7 to 5.2, and 27.3 to 41.4, respectively). Based on the most ubiquitous 76 prairie species (out of 239 recorded), hill prairies that were closer to each other were not necessarily characterized by the same species. Despite this, some less common species, (for example, the sedges *Carex cephaloidea*, *C. eburnea*, and *C. hirtifolia*), occured only in prairies in close proximity to each other. Prairie openings were all smaller than 1/200 ha, although prairie herbs persisting within adjacent forest canopies suggest larger canopy openings in the past, perhaps encompassing one or more of the present-day openings. Hill prairie size was not a good indicator of species similarity or habitat quality either, due to differences in the degree of degradation from factors such as past grazing and erosion caused by off-road vehicles.

Researcher Adrienne Edwards at a hill prairie along the Illinois River. Photo courtesy of Jason Koontz, INHS Center for Wildlife and Plant Ecology

Land use history may well be one of the most important factors determining the quality of any given hill prairie, but substantial differences in species composition and habitat quality could be maintained across landscapes. Hill prairies are a unique natural feature of the Tallgrass Prairie, and we need to document patterns of species diversity and habitat quality to prevent further loss in the future. It may be more efficient to preserve clusters of hill prairies embedded in the landscape than to preserve isolated examples of these dynamic habitats.

Adrienne L Edwards and Jason A Koontz, Center for Wildlife and Plant Ecology

New INHS Publications



Illinois Natural History Survey Special Publication 26—
The Illinois Breeding Bird Atlas

by

Vernon M. Kleen, Liane Cordle, and Robert A. Montgomery

xviii + 459 pp.

softbound

8.5 X 11 inches

$25.95 (price includes shipping)

ISBN # 1-882932-07-2

The Illinois Breeding Bird Atlas project is a comprehensive statewide survey of the birds that breed in Illinois. The introductory sections include a description of the project, its methodology, and a summary of results. The species accounts section includes information on the range, abundance, breeding habitat, life history, historical status, recent population trends, and distribution in the state for species which bred in Illinois during the Atlas project period.

Ordering information:

Contact: Ruth Johnson—(217) 333-6880; rjohnson@inhs.uiuc.edu
Illinois Natural History Survey
Distribution Office
607 E. Peabody Drive
Champaign, IL 61820

Illinois Natural History Survey Special Publication 27—
Assessment of Created Wetland Performance in Illinois
by
Allen E. Plocher and Jeffrey W. Matthews

ii + 22 pp.
paperback
8.5 X 11 inches
$6 per copy

This new publication provides an easy-to-use procedure to assess newly created or restored wetlands in Illinois. Included are color photos that show examples of successful versus unsuccessful restoration efforts, as well as sample assessment forms to help determine wetland status, functional problems, and specific requirements.

Ordering information:

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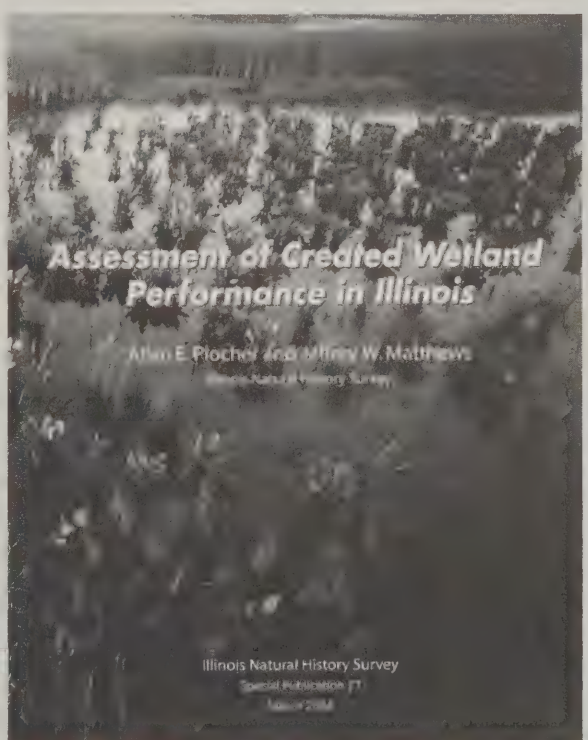


Species Spotlight

Bur Oak

Susan Post

"*When the first settlers gazed westward across the vast prairies of Illinois, bur oaks were the burly trees on knolls and ridges which stood like ships in a sea of grass.*"
Roberts Mann
Nature Bulletin No. 708
Cook County Forest
Preserve, 1963

The bur oak is a tree primarily of the midwestern and Great Plains states. Found further north than any other native American oak, it ranges north to central Manitoba and south to central Tennessee and southern Texas. It is present in all Illinois counties. Bur oaks grow on sites with deep rich soils that are moist but well drained, as well as dry upland sites. In the heart of its range the bur oak is often found growing by itself, standing alone in a farmer's plowed field or in a flat bottomland. When grown in the open, the straight trunk supports a broad, irregular crown of stiff, gnarled branches, with the lower ones decidedly drooping. Under forest conditions, the crown is rather small and the trunk long and clear.

Bur oak acorns with distinctive large, scaled, fringed cups. Photo by Michael Jeffords, INHS Office of the Chief

The bur oak even played a role in the Lewis and Clark Corps of Discovery. The Council Oak at Sioux City, Iowa, was a bur oak. Here during the week of August 13–20 in 1804, the tree shaded a meeting with Native Americans.

Its scientific name (*Quercus macrocarpa*) means oak with a large seed and refers to the large acorns. Its common names include prairie, bur, and mossy-cup, with the latter two referring to the seed, which is enclosed in a knobby cup with a fringed edge.

Bur oaks have simple, rounded, lobed leaves with a deep sinus (space between two lobes of the leaf) near the center of the leaf that appears to split the leaf in half. The leaf will have 5 to 7 lobes and is 15 to 30 cm long and 7 to 15 cm wide. The leaves are arranged alternately on the twigs and are dark green and shiny from above. Below, they appear pale and somewhat hairy. Not much fall color is present as the leaves turn dull yellow or yellow green to yellow brown. The twigs are stout and yellowish brown and smooth, and as they age they develop corky ridges. Its acorn is 1.9 to 5.0 cm long and enclosed half or more in a deep cup adorned with conspicuous scales forming a gray-fringed margin. The kernel of the acorn is sweet and provides excellent mast.

The bur oak's trunk bark is dark brown to gray, rough and deeply ridged. The bark is also thick and resistant to fire, allowing the bur oak to be the most abundant tree in many groves where the forest met the fire-prone prairie.

Paul Strode, a recent University of Illinois doctoral student, used a prairie grove to look at the effects of global climate change on warblers and their food source. An interesting observation resulted. According to Paul, "For centuries, songbirds migrating through east-central Illinois from South and Central America to Canada depended on oaks like the bur oak to supply them with caterpillars as a food resource. By observing the foraging behavior of wood warblers and vireos at Trelease Woods outside Urbana in spring, I found that bur oaks are still a critical tree species for these long-distance migrant songbirds. Warblers and vireos preferred bur oaks disproportionately to their availability in the forest, and bur oaks were found to contain over twice as many caterpillars per leaf than sugar maple and hackberry, the two most dominant tree species in the forest. My results are a strong indication that conserving bur oaks in our Illinois forests would help to conserve populations of wood warblers and vireos."

Magnificent bur oak tree Photo by Michael Jeffords, INHS Office of the Chief

Continued from facing page

trees may have been planted by people. Some of these trees may not be native to the area. Oaks occur over much of the Northern Hemisphere, and many European oaks are widely planted in North America. Some plant nurseries are even crossing European and North American oaks to produce new types of trees.

Mohlenbrock, Robert H. 1980. *Forest Trees of Illinois*. Eight edition. Illinois Department of Natural Resources, Division of Forestry, Springfield. 331 pp.

Mille, Howard and Samuel Lamb. 2003. *Oaks of North America*. Naturegraph Publishers Inc, Happy Camp, California. 327 pp.

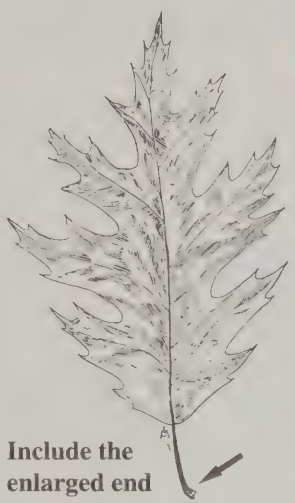
The Naturalist's Apprentice

Make an Oak Tree Collection

Carolyn Nixon

To learn how to identify the oaks in your area, you can make an oak collection. No, you won't be collecting trees; just parts of trees! By making a collection of leaves, acorns, winter buds, and bark rubbings, you will have much of the information you need to identify the tree. You can make this collection from oak trees on school grounds or nearby parks and natural areas. Before you collect anything from the trees, make sure you get permission from the landowner or property manager. Collecting leaves and acorns and taking bark rubbings will not harm trees. The leaves and acorns of an oak tree will be shed in the fall, anyway. Collecting twigs with buds should be done with care. Do not take too many buds from one tree as these are the next year's leaves.

Leaf Collection: Use a letter-sized spiral notebook for your leaf collection. Making a leaf collection can be done any time that the leaves are on the trees. However, it is best to wait until the leaves have reached their full size in late spring or when the leaves are shed in the fall. Once you have found a tree from which you want to collect, rccord some information about the tree. Include the date, where ther tree is located, and a general description of the tree. A quick sketch of the shape of the tree can be useful (see the illustration). Give the tree a number on you notebook page. Anything else you collect from this tree will be given the same number. Carefully pull the leaf from the twig by pushing against the base of leaf petiole (the leaf stem) next to the twig. By doing this, you should retain the wide, flared end of the petiole. This may be helpful in leaf identification. Flatten the leaf against the notebook page and close the notebook. Turn four or five pages before you collect a leave from another tree. Once you have collected all the leaves you need, place the notebook on a flat surface and place a heavy book on top of it. Let it sit undisturbed for at least two weeks. This will allow the leaves to dry, and they will then remain flat. After they are dry, you may tape the leaves down to the page.



Include the enlarged end of the leaf stem.

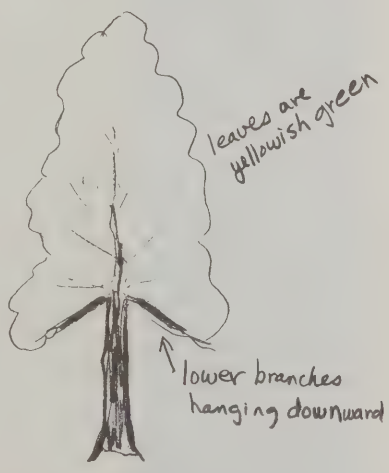
Acorn Collection: To make an acorn collection you will need several small paper bags and some 3" by 5" index cards. Pull the acorn from the tree, or pick one up from the ground directly below the tree. Make sure the acorn cap is attached. Place the acorn into a bag. Write the number on the index card. Remember, this is the same mumber you used for the leaf collection. If no leaf was collected, include the information about the tree as well (date, location, description, and sketch). Acorns from different trees should go into separate bags. The acorn collection can easily be stored in egg cartons or divided boxes. Be sure to include the tree number for each acorn on a label that is placed in the compartment with the acorn. If only a few acorns are collected, the egg cartons are easily cut in half.

Tree 3

Tree in front of school.
Sept. 1, 2003

Bark Rubbings: Hold a piece of unlined paper against the trunk of the tree. Vigorously rub over the paper with a crayon. This should give you a reasonable picture of the bark. Make sure you write the tree number on the piece of paper and record the other information (date, location, etc.).

Bud Collection: Once the leaves have fallen from the oak trees in the fall, and before the leaves begin to come out in the spring, you can collect a twig with its buds. Cut a short piece of twig from the end of a branch (3 or 4 inches should be adequate). Tape the twig down to a notebook page and number the twig. If you know it was the same tree from which leaves or acorns were collected, use the same number that was used for the tree. Record the date, location, and description of the tree on the notebook page next to the twig. Use a new page for each tree.



Sample tree sketch

Once you have your oak collection, use a field guide and try to identify each tree from your collected leaves, acorns and twigs, and your bark rubbings. Do not get discouraged if you cannot determine the species of oak you have found. Oaks can be difficult to identify. Sometimes oaks are hybrids (crosses of two different tree species). Also, if leaves are collected around homes or parks, the

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Contamination

continued from front page

low levels (e.g., sodium, chloride, sulfate) can reach high enough concentrations to impair sensitive aquatic organisms. Despite this, the United States Environmental Protection Agency (U.S. EPA) does not currently set limits for protection of aquatic life on the amount of sulfate or sodium allowed in industrial effluents. However, several states, including Illinois, are in the process of developing new standards for sulfate. Current research being conducted at the Illinois Natural History Survey will support this new standard by determining how much sulfate may be released into receiving streams without causing impairment of the aquatic fauna.

Sulfate toxicity, and therefore sulfate standard development, is turning out to be more complicated than originally thought. For example, our work has shown that increased water hardness decreases sulfate toxicity. In other words, when there is more dissolved calcium (one of the elements that determines water hardness) in a water body, the organisms inhabiting that water body can tolerate much more dissolved sulfate than if there was less calcium. This is likely a result of calcium reducing gill permeability, and therefore, the amount of sulfate that can enter the body and cause toxicity. Because of this, regulators might have to set standards for sulfate that vary based on the hardness of the water body to receive the effluent (a practice common for metal standards). An additional complication we have found is that for some organisms, like the scud, *Hyalella azteca* (a type of amphipod crustacean), the amount of dissolved chloride in the water controls sulfate toxicity. Our experiments suggest that reducing chloride from 30 mg/L to less than 5 mg/L reduces the safe amount of sulfate for *Hyalella* from about 2000 mg/L to about 200 mg/L. Obviously this complicates matters for both regulators and coal processing facilities that will be regulated by these forthcoming standards. Additional research is required to further clarify how different water quality parameters affect sulfate toxicity, but this work will help Illinois become one of the first states to have science-based limits on sulfate concentrations in industrial effluents for the protection of aquatic life.

David J. Soucek and Joan C. Esarey, Center for Ecological Entomology

Illinois Natural History Survey Reports is published quarterly by the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the Illinois Department of Natural Resources.

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Reports

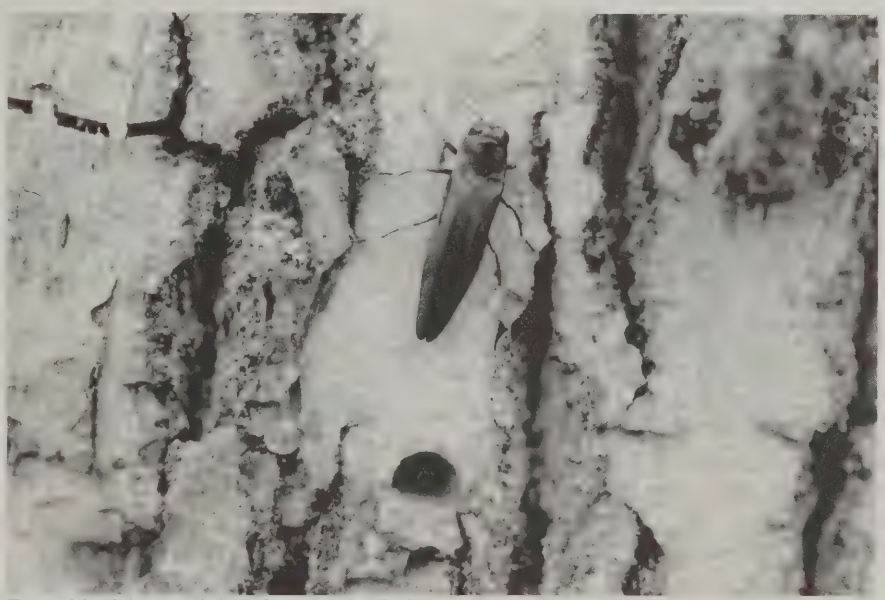
ILLINOIS
DEPARTMENT OF NATURAL RESOURCES

Autumn 2004
No. 381

INSIDE

Emerald Ash Borer, a Potential New Illinois Pest

Emerald ash borer, *Agrilus planipennis,* is an insect new to North America that attacks and kills healthy ash trees. Its native range includes China, Korea, Japan, Mongolia, the Russian Far East, and Taiwan. It was first identified in the Detroit, Michigan area in July 2002. Since then it has also been found in other areas of Michigan, the Windsor, Canada area, areas of Ohio, and other locations outside of the Midwest.



Emerald ash borer adult and emergence hole. **Photo by Phil Nixon, University of Illinois**

Ash trees are important in our residential landscapes, towns, cities, and forests in Illinois. In many communities, ash trees comprise 10 to 20 percent of the trees.

Emerald Ash Borer in North America, 2004.

Map courtesy of U.S. Forest Service

Adult beetles are $^{1}/_{3}$ to $^{1}/_{2}$ of an inch long and elongate with metallic emerald green wing covers on a greenish-bronze body. They emerge primarily in late spring through $^{1}/_{8}$-of-an-inch-wide, D-shaped holes in the bark of ashes. Adult beetles are present through June into mid-July. After mating, the female inserts her eggs, one or two at a time, between bark flakes.

The eggs hatch into larvae that tunnel through the bark into the cambium where the water, nutrient, and sugar conducting tissues, the xylem and phloem, are located. The larvae are white, elongate, and flattened, growing to about 1 $^{1}/_{2}$ inches long. The larvae pupate in the cambium and emerge the following spring.

The larvae create slender, winding tunnels that frequently wind back and forth, creating a series of S-shapes that run into one another. Just as commonly, the tunnels meander under the bark with no particular pattern. As the tunnels become numerous, they effectively girdle a branch causing it to die due to lack of water and nutrients.

Emerald ash borer attacks the top of the tree first, causing dieback. Attack continues down the tree, resulting in the gradual death of branches until the entire tree dies in two to three years. The bark on attacked trees separates from the tree trunk, allowing the larval tunnels to be easily seen. Once the tree dies to the ground, suckers form around the base of the trunk, but they do not grow into strong, attractive trees.

The Morton Arboretum in Lisle, IL, sponsors an Illinois emerald ash borer readiness group whose purpose is to prepare the state for the possible occurrence of this pest in Illinois.

Continued on back page

The Illinois Gap Analysis Project

The goal of Gap analysis is to identify the degree to which native species and communities are represented in the existing network of conservation lands. The Illinois Gap Analysis Project (IL-GAP), which is part of the National Gap Analysis Program, is in the final stages of completion. Gap analysis involves development of vertebrate species habitat models based on land cover, existing range or point distribution data, and ancillary data relative to a species' habitat (i.e., soils, natural divisions, edge, and riparian buffer masks) for mammals, birds, amphibians, and reptiles. Predicted species distributions are combined with stewardship boundaries to identify potential habitat that should be targeted for conservation planning. Maps showing statewide species richness and abundance provide a picture of biodiversity or "hot spots."

The first component of Gap is the statewide land cover layer. The Gap land cover dataset was developed in conjunction with the Illinois Interagency Landscape Classification Project, which recently published a map entitled "Illinois Land Cover" in collaboration with the Illinois State Geological Survey. (This map is available from the INHS publications office for $10). The Gap land cover dataset was created using Landsat Thematic Mapper (TM) satellite imagery from 1999–2000. Twenty-nine land cover categories were identified. For IL-GAP, forests were classified to the community level based on communities identified for the Illinois Natural Areas Inventory. The land cover of Illinois is classified as 64.7 % agriculture, 13.4 % grassland, 14.6 % forest, 4.5 % urban/developed, <1.0 % nonforested wetlands, and 1.7 % water.

The next component is vertebrate distribution mapping and modeling. Point location data from various sources (i.e., museum collections, surveys, etc.) were collected for each vertebrate species. The distribution of each species was mapped at the Gap hexagon level based on the point location data (Figure 1.) Each hexagon is 635 km^2 and this determines the range

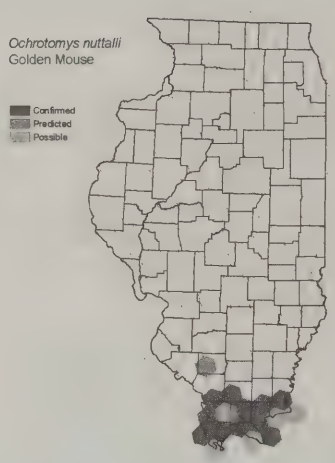


Figure 1. Hexagon range distribution for the golden mouse based on museum point locations and expert review.

boundaries used for IL-GAP for each species. Habitat associations for each species were determined from a review of scientific literature. A predicted species distribution model was then created for each species based on the combination of habitat associations, model modifiers from ancillary data, and the hexagon range distributions (Figure 2). For IL-GAP a total of 474 individual species were modeled—60 mammals, 311 birds, 41 amphibians, and 62 reptiles. Among birds, we modeled breeding, migratory, wintering, and permanent resident habitats for each species, generating 735 individual models.

Land stewardship mapping and categorization comprised the third component of the project. Boundary maps of the known owned, managed, and leased conservation-related properties in Illinois were obtained from various sources (i.e., IDNR, county forest preserve or conservation districts, etc). Each property was assigned ownership and management entities, a Gap status code indicating level of management, and the data source of the boundary information. The final component of IL-GAP is the determination of "gaps" in the protection of vertebrate species and their habitat areas managed primarily for natural values. Identification of a "gap" indicates potential risk of decline, including extinction or extirpation, of species and indicates areas land stewards and decision makers should target for protection.

In the example of the golden mouse *(Ochrotomys nuttalli)*, a threatened species in Illinois, the scientific literature states that they occur in bottomland and pine forests, elm-mulberry-sweetgum forests, and oak-hickory forests with dense understory of green briar. The predicted distribution model for the golden mouse includes dry-mesic, mesic, coniferous, mesic floodplain, wet-mesic floodplain, and wet floodplain forest land cover categories. The Gap analysis results show that the total predicted distribution area for the golden mouse is 267,340 hectares or 1.83% of the land

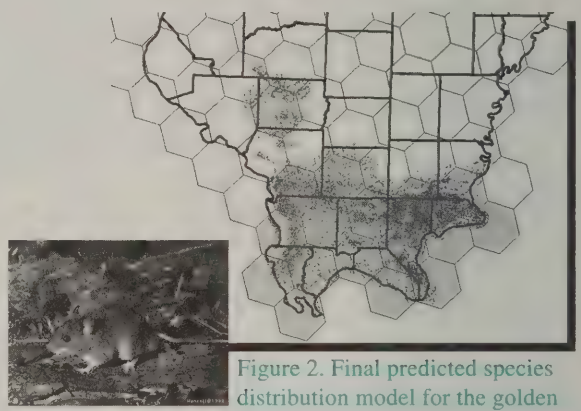


Figure 2. Final predicted species distribution model for the golden mouse clipped to the hexagon range.

area of Illinois. Of the 267,340 hectares, only 13,765 hectares (5.15 %) of the predicted area is currently in highly protected management status. More information on the Illinois Gap Analysis Project can be found at (http://www.inhs.uiuc.edu/cwe/gap/). IL-GAP data will eventually be placed on this Web site for download.

Tari Tweddale, Center for Wildlife and Plant Ecology

Frequency of Early Mortality Syndrome in Southwestern Lake Michigan Lake Trout Populations

Dr. Sergiusz Czesny (Illinois Natural History Survey) is collecting lake trout eggs for thiamine analysis and Early Mortality Syndrome study (November 2003). **Photo by staff of INHS Lake Michigan Biological Station**

Self-sustainable lake trout, *Salvelinus namaycush*, populations in Lake Michigan are a primary but unmet goal of fisheries managers in the region. Large numbers of hatchery-origin lake trout are stocked into Lake Michigan every year. Although these fish survive well to adulthood and produce viable eggs, no significant natural recruitment has been recorded. Poor lake trout recruitment in various systems has been linked with insufficient broodstock, diminished spawning habitat, contaminants, predation on eggs and alevins, and nutritional deficiencies. However, no clear cause for lack of natural recruitment has been identified for Lake Michigan lake trout. Nutritional deficiencies associated with inadequate levels of thiamine (vitamin B_1) in the eggs result in high mortalities of yolk sack stages of several salmonid species in the Great Lakes and in the Baltic Sea. Mortality caused by thiamine deficiency, commonly referred to as Early Mortality Syndrome (EMS), is a consequence of high levels of thiaminase, an enzyme that degrades thiamine, found in prey fishes such as alewife, *Alosa pseudoharengus*, and rainbow smelt, *Osmerus mordax*. Because alewife is a major component of the lake trout diet in Lake Michigan, we hypothesize that EMS may be a significant bottleneck in the survival of early life stages of this species.

With collaborators at the Ohio State University, we are investigating individual variation in thiamine levels in the eggs of Lake Michigan lake trout at the time of spawning (picture). Eggs are fertilized, incubated, and hatched under controlled laboratory conditions. High performance liquid chromatography (HPLC) is used to determine concentrations of vitamin B_1 in the eggs. Finally, we quantify mortality caused by EMS in young lake trout and correlate it with levels of thiamine found in eggs from individual females.

Results to date indicate that egg thiamine concentration varies by an order of magnitude among investigated females (from 0.28 ± 0.04 to 3.83 ± 0.61 nmol/g eggs). More than 50% of all females sampled produced eggs with free thiamine levels below 0.8 nmol/g. Once free thiamine levels fall below 0.8 nmol/g, EMS incidence soars dramatically among lake trout offspring in Lake Ontario. Post-hatch mortality attributed to EMS occurred between 700 and 900 degree days, an age at which lake trout offspring are swimming and actively looking for food.

Understanding the potential importance of EMS as a regulator of lake trout reproductive success is critical for the effective management of this native Lake Michigan fish. These findings extend our ability to interpret the role of EMS in the lake trout recruitment dynamics. For instance, the actual number of spawning lake trout needed to generate natural reproduction in Lake Michigan may be underestimated by 50% or more once losses associated with EMS are taken into account. Because of the possible significance of our findings for managers, it will be essential to investigate lake-wide variability of thiamine deficiency as well as the importance of EMS compared to other sources of early mortality among Lake Michigan lake trout.

Sergiusz Czesny and John M. Dettmers, Center for Aquatic Ecology and Conservation

Neartic Therevid Genera Revision Nears Completion

The Therevidae (Insecta: Diptera) are a world-wide family of flies (see drawing) that inhabit forests, prairies, deserts, and sand dunes. Adults are not of economic importance and do not feed, but occasionally imbibe water or nectar. Often they alight in sunny patches on trails and paths, the males usually awaiting passing females. The snakelike larvae burrow through sandy and sandy-loam soils and are voracious predators, feeding on a variety of earthworms and fossorial arthropods, in particular the larvae of beetles. Very little ecological information is available on these flies.

Over 2,100 species have been described world-wide, but the family is poorly known from Australia, South America, and Asia. Few comprehensive revisions have been published since the 1920s, with only a small number of genera from Europe and South Africa revised by Leif Lyneborg (University of Copenhagen). In 1981, Michael Irwin (University of Illinois and Illinois Natural History Survey) and Lyneborg published in the Bulletin of the Illinois Natural History Survey 32(3):193–277, *The Genera of Nearctic [North America] Therevidae*. They outlined 30 genera of North American therevids, 16 of which were new to science. This publication brought together a listing and generic association of over 130 species of therevids in North America, of which one-third of the species occur in and around Illinois. This publication initiated a collaborative association between Donald Webb (INHS) and Michael Irwin to revise the various genera of North American therevids and to provide an update of the nomenclature of each species; a redescription of extant species or the descriptions of new species; illustrations of the male and female terminalia; keys for identification of each species; distribution maps; and when feasible a phylogenetic hypothesis was proposed for the various species within each genus. To date, 20 of the 30 Nearctic genera have been revised. In 1995, support for this program was obtained from the National Science Foundation PEET Program (Partnerships For Enhancing Entomological Expertise in Taxonomy) and the Schlinger Foundation for a Worldwide Monograph of the Therevidae. This program included Brian Wiegmann (North Carolina State University) to work on the molecular phylogenetics of the Therevidae, David Yates (University of Brisbane, Australia/CSIRO) to develop a morphological phylogeny of the therevid genera and to establish the relationships of the Therevidae within the Infraorder Asiloidea, and Chris Thompson (U.S. Department of Agriculture/Smithsonian Institute) to assist in nomenclatural problems and the databasing of information.

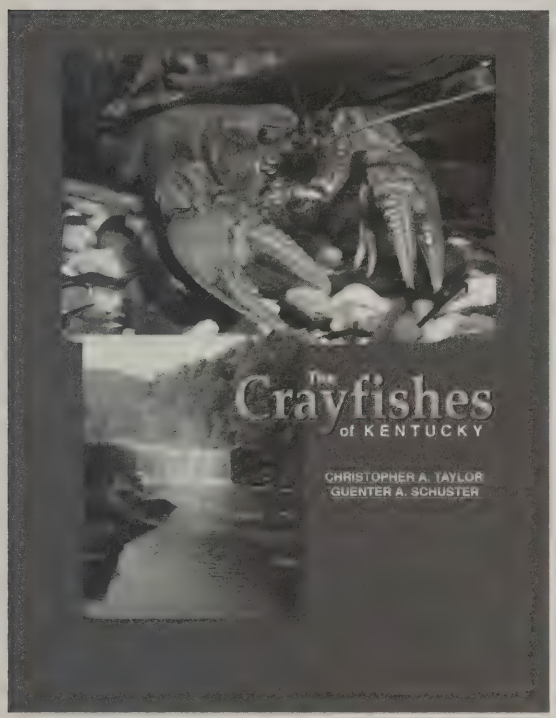
A therevid from the genus *Brachylinga*. **Computer-generated drawing by J. Marie Metz, Smithsonian Institution**

A critical part of this PEET program was the training of new systematists. To date, five doctoral and two Masters degrees have been conferred. Gail Kampmeier of INHS developed an interactive database (MANDALA, www.inhs.uiuc.edu/cee/therevid/) for the PEET Program to integrate information on each species and specimen. Each specimen examined has been given a unique MEI number and over 120,000 therevid specimens have been entered into the database. Scientists can search the database utilizing a World Wide Web site for a specific species and obtain all current information on generic revisions, species descriptions, current nomenclatural status, and all published references to the species. Currently, Webb and Mark Metz (a doctoral graduate of this PEET Program and a research affiliate of the INHS) are revising the *Brachylinga-Lysilinga* complex for the New World. This study involves the examination of over 12,000 specimens (including 30 type specimens) borrowed from various museums and collections throughout the New World and Europe. Thirty species had previously been described and 29 species and 1 genus are being described as new to science. All that remains of this revision is the phylogenetic analysis of the species and an interpretation of their biogeography in relation to dispersal patterns within Mesoamerica and the Caribbean.

This PEET project ends in 2005, but by then almost all of the Nearctic genera of therevids will have been revised.

Donald Webb, Center for Biodiversity

New INHS Publications



Illinois Natural History Survey Special Publication 28 —
The Crayfishes of Kentucky
by
Christopher A. Taylor & Guenter A. Schuster

250 pp.
hardback with dust jacket
8.5 X 11 inches
$20 per copy (includes shipping and handling)

Replete with color photos of each species, detailed drawings of crayfish anatomy, and distribution maps, *The Crayfishes of Kentucky* provides a unique and detailed guide to the state's diverse populations of crayfishes and their habitats. Students, naturalists (both professional and amateur), and educators will find this publication an indispensable tool.

Ordering information:

Contact: Ruth Johnson—(217) 333-6880; rjohnson@inhs.uiuc.edu
Illinois Natural History Survey
Distribution Office
607 E. Peabody Drive
Champaign, IL 61820

Illinois Natural History Survey Biological Notes 141 —
The Freshwater Mussels (Bivalvia: Unionidae) of the Fox River Basin, Illinois and Wisconsin
by
Robert W. Schanzle, Glen W. Kruse, Joseph A. Kath, Roger A. Klocek, and Kevin S. Cummings

iv + 35 pp.
paperback
8.5 X 11 inches
$6 per copy (includes shipping and handling)

Freshwater mussels in the Fox River basin were surveyed during 1997–2001. Ninety-six stations were sampled resulting in the collection of 27 species of native mussles and 2 species of introduced mussles. This publcation provides detailed species descriptions and range maps for each of the collected species plus tables comparing the results of the current survey with those of previous surveys going back to 1874.

Ordering information:

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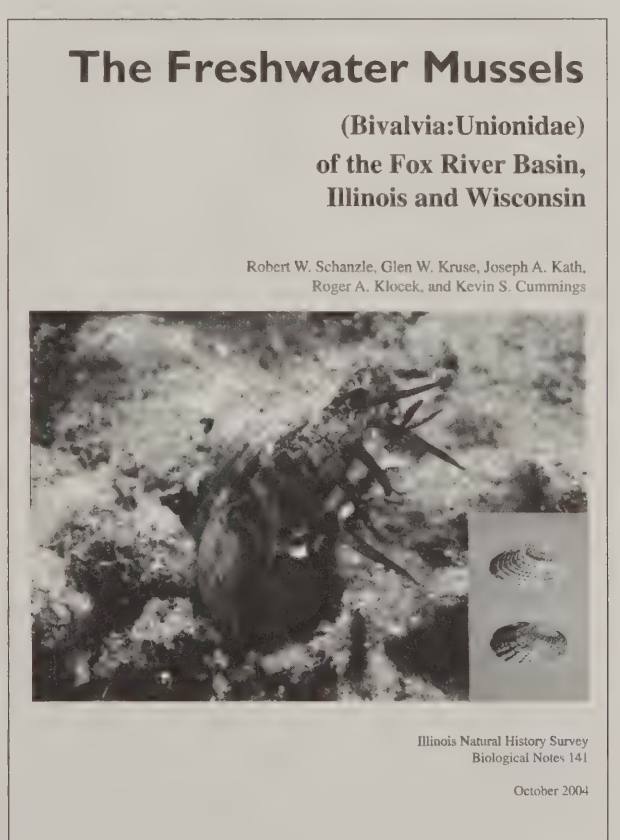


Species Spotlight

Spiny Softshell Turtle

Susan Post

Author Susan Post rescues a spiny shoftshell turtle from a roadside. Photo by Michael Jeffords, INHS Office of the Chief

While walking along the Cache River in southern Illinois this summer, I noticed a flattened boulder along the side of the stream. Using my binoculars I realized this wasn't a rock but a large turtle, basking in the sun. Back at the car, I pulled out my *Amphibians and Reptiles of Illinois* and discovered I had seen a female spiny softshell turtle, *Apalone spinifera*—a new species for my Illinois reptile and amphibian life list and one that I wanted to learn more about.

Of Illinois' 60 species of reptiles, perhaps the most highly adapted for an aquatic existence are the state's two species of softshell turtles—smooth and spiny. The spiny softshell turtle occurs throughout the state in lakes, sloughs, mud-bottomed streams, and sand-bottomed rivers. It is most abundant in the latter. These turtles spend most of their time in well-oxygenated water either foraging, floating at the surface, or buried in the soft bottom with only their heads and necks protruding.

The exceptional feature of any turtle is its shell, which is divided into two parts, carapace (the upper shell) and plastron (the bottom part of the shell). Both parts of the shell are made up of bones that are covered with a horny scalelike covering called scutes. Softshell turtles have an almost circular upper shell; instead of scutes, both their carapace and plastron are covered with soft and leathery skin. The carapace bends and the edges droop like a flap over the hole through which the head and neck are withdrawn in time of danger. When removed from the water, softshell turtles resemble gray pancakes and this has led to common names of flapjack or pancake turtles.

Spiny softshell turtles are dull-olive in color with narrow yellow borders. They have numerous black rings scattered over their carapaces and spiny projections along their anterior edges. Their heads are olive with yellow, black-bordered stripes on each side of the head and neck extending through the eyes. Their limbs are olive-spotted and marbled in black with paddlelike feet. Females are usually twice the size of the males. Carapace length can be 18 inches in females and 8.5 inches in males. They have long necks, narrow heads, and snouts that are slender proboscises. Their skin is three to four times more permeable to water than that of hardshell turtles. Thus, if kept out of water for two to three days, they may die of dehydration.

Fleshy lips cover strong mandibles, hiding the fact that these turtles can bite with the force of snapping turtles. While these turtles may look like pancakes, they have long necks, cutting jaws, raking claws, and are capable of sudden movement. They run with great speed for a turtle and swim even faster.

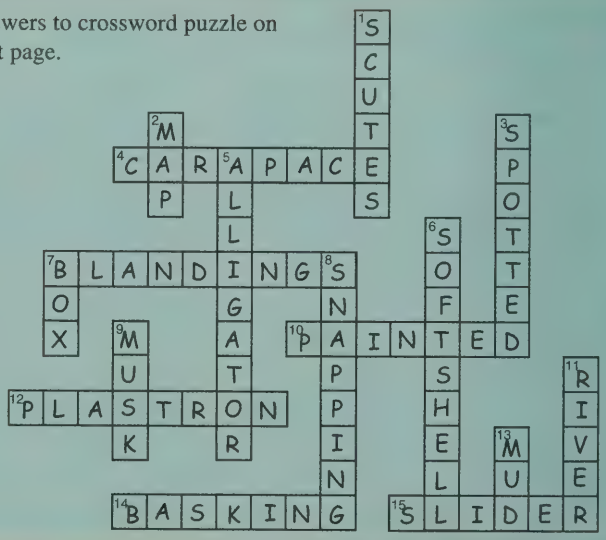
Spiny softshell turtles spend a lot of time basking on rocks, logs, or sandbanks. While basking they usually turn to face the water, ready to make a rapid escape. These turtles are impossible to stalk and once alarmed they are difficult to overtake. They usually bask alone, and not before 10:00 a.m.

Spiny softshell turtles will bury themselves in the sand at the very margin of a stream; inconspicuous craters mark the sites where they are buried. They lie just deep enough for their long pointed snouts to reach the surface for air, like snorkels. However, they don't have to get air from the surface. While the turtle is submerged, it pumps water in and out of its mouth and pharynx. The highly vascular lining of the pharynx removes oxygen from the water and expels carbon dioxide into it. From late October until late April or May, the turtles bury themselves in sand or mud and remain until temperatures warm. They will hibernate beneath the water in about two to four inches of substrate.

Once mating occurs (late spring) the female will nest, laying her eggs in sand or soil, which is close to the water and in full sun. She will nest from mid-May until July and will lay an average of 18 spherical, brittle-shelled eggs. She can have up to four clutches of eggs per season. Hatchlings are in evidence by late August.

Spiny softshell turtles are carnivorous, feeding on crayfish, fish, and aquatic insects. When feeding they crawl or swim along the bottom of the water in a random fashion, thrusting their snouts under stones into masses of aquatic vegetation. They will take prey from ambush and also actively pursue it. These turtles are not without their predators. Skunks and raccoons destroy their nests; fishes, snakes, wading birds, and other turtles eat the young. The biggest problem for adults is decapitation by fisherman after being hooked on their lines.

Answers to crossword puzzle on next page.



The Naturalist's Apprentice

Turtle Cross-word Puzzle

Carolyn Nixon

Turtle Crossword Puzzle

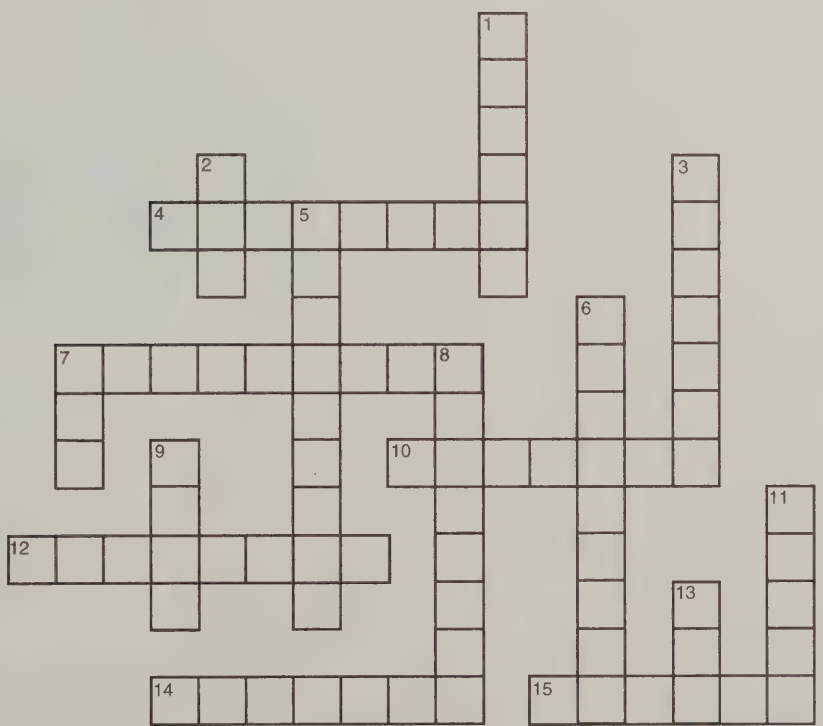
Names of Illinois turtles and turtle facts are used in the crossword below. A list of the turtles that can be found in Illinois will help answer the clues. You might consult the book *Field Guide to Amphibians and Reptiles of Illinois*, published by the Illinois Natural History Survey.

Across

4. Name for the upper part of a turtle shell.
7. _____ turtle is named for a person, and really isn't all that dull and boring.
10. The _____ turtle was not designed by artists, but looks like it could have been.
12. Name for the bottom side of a turtle shell.
14. When turtles sit on a log on a sunny day they are _____.
15. From its name, you might think that this turtle spent time on a playground, or that it was a baseball pitch that curves at the last second.

Down

1. The large scales on a turtle shell are called _____.
2. The Ouachita, Common, and False _____ turtles shouldn't get lost on the trail.
3. The _____ turtle has yellow dots all over it.
5. This turtle, which is related to 8 down, is not related to crocodiles.
6. The spiny and smooth _____ turtles have a leathery shell.
7. The ornate and eastern _____ turtles can close up their shells and hide.
8. The _____ turtle can give you a good bite.
9. The _____ turtle has a strong odor.
11. The _____ cooter lives in backwaters of large streams.
13 The yellow and eastern _____ turtles live in wet areas, where your feet could get a lot of sticky, wet soil on them.



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Ash Borer

continued from front page

The group consists of representatives of various municipal, state, and federal organizations, professional horticultural groups representing nurserymen, landscapers, and arborists, and other appropriate professional organizations. The Illinois Natural History Survey is represented by Charles Helm as well as James Appleby and Philip Nixon from the University of Illinois who are Survey affiliates. These three entomologists are surveying Illinois for the borer and providing educational information about this insect across the state as well as using their professional knowledge and expertise to influence the direction taken by the readiness group.

We think that emerald ash borer is most likely to enter Illinois by individuals bringing in young ash trees or firewood from infested areas. The commercial sale and movement of nursery stock out of infested areas has been forbidden through federal quarantine. To help reduce the spread of infestation from occurring, billboards have been placed along interstate highways leaving Michigan asking people to not take firewood out of the state.

Urban tree damaged by the emerald ash borer. **Photo by Phil Nixon, University of Illinois**

If you see emerald ash borer or its damage, contact your local University of Illinois Extension Office or the Illinois Department of Agriculture at 800-641-3934.

Philip L. Nixon and James E. Appleby (University of Illinois, Urbana-Champaign), Charles G. Helm, Center for Ecological Entomology

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